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EDITORIAL.

Organic Matter and Nitrogen in Malayan Soils.

The article by R. G. H. Wilshaw on organic matter and nitrogen in Malayan soils, which is included in this issue, forms Part III of the series of Studies in Malayan Soils. Part I of the series was published in the August 1933 number of this Journal and discussed the classification and properties of Malayan soils, while Part II, which appeared in October of the same year, dealt with problems of manuring of inland soils.

The present paper describes experiments which have been carried out to ascertain to what extent the accepted views on the carbon and nitrogen cycles, which take place in soils, can be applied under conditions obtaining in Malaya. The necessity for the proper understanding of the functions of these two elements is obvious, seeing that carbon is primarily concerned with the formation of plant tissue and nitrogen with processes of growth.

Malayan inland soils of the quartzite or granite type are normally deficient in organic matter, which tends to accumulate in soils in which the activity of micro-organisms is curtailed. In Malaya, in general, conditions are ideal for the rapid and complete decomposition of soil organic matter into carbon dioxide, water and simple inorganic nitrogen compounds, and in the soil, practically no formation of what is called "humus" occurs. As a result of the addition of organic matter in the form of green manures, however, there is a rapid production of ammoniacal and nitrate nitrogen which is absorbed by growing plants with a resultant stimulation of growth.

One conclusion of very great practical value which emerges from this paper must be mentioned. The author concludes that, contrary to the view usually held, plants thrive best if green matter is turned in *shortly before planting.* The turning in of a green manure some time before planting results, under the tropical conditions obtaining in Malaya, in the liberation of ammoniacal nitrogen, which under fallow conditions is lost; whereas, under non-fallow conditions, this ammoniacal nitrogen is rapidly changed to nitrate nitrogen and hence is of immediate benefit to the plant which is then at an early stage of growth and therefore likely to respond readily to this supply of plant food.

There are many questions connected with organic matter in soils and the behaviour of green manures, as well as problems relating to the nitrogen cycle particularly under field conditions, which remain unsettled. The article indicates the lines on which future work will be directed as a result of the observations made to-date during the course of the experiments on these complex problems.

The Oil Palm in Sumatra.

In May 1933, Mr. J. N. Milsum of the Department of Agriculture S.S. and F.M.S. visited the east coast of Sumatra with the object of studying the recent advances in connexion with the oil palm industry in that country.

The article entitled "The Oil Palm in Sumatra", which is published in the present number of the Journal, gives an outline of some of the more important points of interest observed during his visit, and should form a useful supplement to the information contained in the new edition of the Manual on Oil Palms in Malaya which is about to be published by the Department of Agriculture S.S. and F.M.S.

There is an area of some 155,000 acres under oil palm cultivation in Sumatra, and during the past fifteen years, the area under oil palms in Malaya has increased considerably—from 225 acres in 1917 to 61,000 acres in 1933.

The methods of cultivation adopted appear, on the whole, to be similar in both countries and it is interesting to note that in Sumatra, as in Malaya, the question of manuring with artificial fertilisers is receiving considerable attention. In this connexion, the practice in Sumatra of growing a trial crop of maize on an experimental plot, with the object of assessing the phosphatic requirements of the soil in an area, merits attention.

The importance of using seed of known parentage when planting new areas of oil palms is now well recognised; in Sumatra, where this has been an established practice for a longer period than in Malaya, the results to-date are stated to have justified the care taken in this matter.

Mushroom Culture.

The growing of mushrooms is an established industry in many parts of the world, particularly in England, France and America where a species of edible fungus (*Agaricus campestris*) is cultivated on a large scale and finds a ready market. This mushroom also grows wild in the fields during the autumn months, especially following a warm summer, and is much appreciated as an article of diet. In Malaya a species of Agaricus, closely related to *A. campestris*, appears mainly during the months of August and September. This species is well known to European residents in Selangor since it grows on the fairways of the golf course at Kuala Lumpur.

In Europe and America, mushrooms are cultivated in especially constructed houses, or in caves, underground passages, or disused barns, as well as in the open air. Considerable trouble is taken in the preparation of the compost of

which the beds are made. This compost is composed of manure, preferably horse manure, with the addition of straw and soil, and spawn is not added until suitable conditions of temperature and moisture are obtained. The preparation of the compost and the care of the beds requires skill and experience, if remunerative crops are to be secured.

Mushrooms are also grown in China and Japan and are exported mainly in dried form; the species most commonly imported into Malaya is not *Agaricus campestris,* but belongs to a related family—Volvariaceae—and is called *Volvaria volvaceae.*

This species is comparatively rare in the temperate zones and usually grows in hot houses or on beds of tanning bark and similar substrata. It is not, so far as is known, looked upon as an edible fungus in these regions, but in the Eastern tropics it is highly prized by Europeans and Asiatics and considered a delicacy.

In 1916, A. S. Vicencio published a paper, in *The Philippine Agriculturist and Forester,* on mushroom culture (Volvaria) in the Philippines. This was followed in 1921 by a paper by O. A. Reinking and W. H. Brown in a Bulletin of the Bureau of Forestry. A more recent paper by C. van Overeem, in the *Bulletin du Jardin Botanique* 1927—1928, gives an interesting account of the methods employed by the natives in Netherlands India, in the cultivation of Volvaria on rice straw.

Attempts to grow the mushroom *Agaricus campestris* in Malaya from spawn imported from England and Australia have, so far as is known, not met with success, at any rate on the plains. This, however, is only to be expected in view of published statements that the optimum temperature for mushroom beds of this species is 50° to 56° F., the working limits being to 50° to 65° F., and that spawned beds are rendered useless by heating to 72°F. or more for brief periods. A temperature of 72° F. maintained for 24 hours is injurious to spawn, and although the mycelium of the fungus will grow in pure culture up to a temperature of 85° F., a high temperature in the beds encourages other organisms which suppress the growth of mushroom mycelium. It appears probable that, if success in the cultivation of mushrooms is to be obtained in Malaya, a species which will grow in this country should be used, and in this connexion an interesting article by Mr. J. A. Baker is published in the present number of this Journal.

The article describes an experiment in the cultivation of *Volvaria volvaceae* on padi straw at the Bukit Merah Padi Test Station in Province Wellesley, where the success obtained warrants the conclusion that it is probable that mushroom growing would form a profitable accessory industry to padi cultivation.

Original Articles.

STUDIES IN MALAYAN SOILS. PART III

BY

R. G. H. WILSHAW,

Agricultural Field Officer,

(*formerly Assistant Soils Chemist*).

In Parts I and II of this series, a general account of the characteristics of Malayan soils and the reactions of these to manuring has been given. This paper gives a short account of the accepted views on carbon and nitrogen changes which take place in soils, and describes experiments which have been carried out to ascertain their applicability under Malayan conditions.

Carbon and nitrogen changes which take place in soils are often referred to as cycles. The carbon cycle is concerned with the building up of plant tissues from the carbon dioxide of the air and the decomposition of these tissues under the influence of micro-organisms with the liberation of carbon dioxide again. Similarly, the nitrogen cycle is concerned with the absorption and fixation of nitrogen by plants and micro-organisms and the changes accompanying decomposition. In that carbon may be regarded as the primary element concerned with the formation of tissue, and nitrogen with progress of growth, these two elements merit special study.

This paper concludes with a summary of the position reached with reference to these changes, together with mention of the lines along which future work will be directed.

Short Summary of the accepted views on Carbon and Nitrogen changes in Soils.*

The cycle of nitrogen and carbon changes which take place in soils is dependent on the organic material present.

The organic matter of the soil is a dynamic constituent representing the balance of accumulative over destructive agencies; that is to say, it represents the difference between the rate of addition of plant residues being incorporated with the soil and the destruction of these residues which is being carried out by a variety of micro-organisms. In itself, moreover, it is the source of its own destruction in that it supports this varied microbiological life.

Organic matter accumulates in soils where conditions tend to be anaerobic and temperature low, that is, under conditions where microbiological life is curtailed. Under aerobic conditions and higher temperatures, microbiological

* The following summary has been freely adapted from 'Soil Conditions and Plant Growth'—E. J. Russell, 1932 Edition.

life increases and decomposition of the organic material proceeds at a higher rate. Under stable conditions, an equilibrium may be reached where decomposition balances accumulation.

The decomposition of plant materials is primarily an oxidation by soil micro-organisms, oxygen being absorbed and carbon dioxide liberated, and is in fact the direct reversal of the process which went on when the plant was originally built up from the carbon dioxide of the air by means of chlorophy. This oxidation process, however, is not complete and a residue is left which in combination with various products, re-synthesised by the micro-organisms in building up their own body substances, gives rise to what is termed humus. Humus, together with the remains of plant material in various stages of decomposition, constitutes soil organic matter.

In this oxidation process, organic substances which have the lowest carbon content such as sugar, starch and cellulose, tend to disappear first, and carbon altogether disappears more quickly than nitrogen; the resultant material in temperate climates usually has a carbon nitrogen ratio of about 10 or 12 to 1.

The micro-organisms which bring these changes about derive their energy for growth from the carbohydrates present, but in order to build up their own body substances, they convert the plant proteins into microbial proteins. If there is any excess nitrogen above that required for their own needs, this is liberated in the form of nitrate. It has been found that one part of nitrogen is immobilised for every 13 to 18 parts of carbon when the soil is acid. If there is any excess of nitrogen in the original material above this amount, it will be liberated as nitrate. If carbon is present in a greater ratio than 12 to 1 to the nitrogen, all the nitrogen present is utilised by the micro-organisms for their own purposes (in the soil they will draw upon any reserves of nitrate that may exist) and the excess carbon is given off as carbon dioxide. Thus, the carbon nitrogen ratio always tends to come back to a fixed value.

Various attempts have been made to follow the course of the decomposition of plant material and the adjoined table shows the general result of the various reactions.

Comparison of Plant Materials with Soil organic matter (Waksman and Tenney).

		Plant Material	Soil organic Matter
Celluloses	...	24.40	3 — 5
Hemicelluloses	...	15.25	5 — 8
Lignin	...	10.30	40 — 50
Protein	...	2.10	30 — 35
Water soluble Protein	...	15.3	Nil

These figures and modern views indicate that, in general, organic material is broken down by means of the rapid decomposition of cellulose and hemicellulose, and that lignin is not decomposed but is altered and exists in close association with synthesised proteins.

The final transient but relatively stable product humus has been the subject of much research and it has been found that humus may be split into a number of distinct fractions by treatment with acid and alkali. Reference is made in the experiments to be described later to two such fractions known as alpha and beta humus. These are obtained by differential treatment of an alkaline extract of soil with hydrochloric acid.

All the micro-organisms active in the soil are dependent upon the organic material present, but some of these organisms have specific actions and their activities are associated with a particular compound or compounds.

In general, it may be stated that practically all bacteria and fungi will decompose sugars and starches. The decomposition of cellulose, however, is different : under acid conditions (pH4 or less) it is limited to fungi : above this, from pH 5.5 to 7.0, bacteria are active : under anaerobic conditions decomposition is confined to clostridia.

There are numerous micro-organisms capable of oxidising specific organic compounds which occur in the soil and whilst these are of importance in themselves in that they prevent the accumulation of toxic products, their mention must suffice for the purposes of this account.

Changes which occur in the nitrogen and the micro-organisms associated with these compounds are, however, of great importance. The nitrogen compounds in plant residues added to the soil, break down to form ammonia so long as the ratio of C/N does not exceed 10 : 1. This change is brought about by various organisms, chiefly *B. Mycoides, B. subtilis, Ps. fluorescens* and *Ps. candatus* and probably enzymes are partly responsible. The ammonia thus produced is changed rapidly into nitrite by the bacteria Nitrosomonas and Nitrosococcus and again rapidly into nitrate by Nitrobacter.

In addition to this change in the form of nitrogen, reverse changes and loss of nitrogen may occur from soils due to denitrification. The conditions necessary are absence of oxygen, the presence of easily oxidisable organic matter, and a reaction between pH 6.4—8.4. The action can be brought about by a large number of micro-organisms.

Happily for agriculture, however, there are various microbiological activities which increase the amount of nitrogen in soils. This increase is obtained from the nitrogen of the air and fixation is brought about by either Clostridia and Azotobacter, free living organisms, or *Bacillus radicicola,* an organism living in symbiosis with leguminous plants.

The total nitrogen content of any soil is, therefore, the balance which exists between these various processes.

It must be remembered that the above views are those which are held in relation to soils of temperate climates. Attention will be drawn in the final remarks of this article to the modifications which must be accepted when applied to the soils of the humid tropics such as Malaya.

Experimental work on Malayan Soils.

The experiments carried out on Malayan soils fall into well defined groups and will be described under the following headings.

I. Pot Experiments on Rates of Nitrification.

II. Loss of Nitrogen by Leaching from Pots treated with Green Cover Crops. The Effect of Azotobacter Innoculation.

III. Decomposition of *Crotalaria usarmoensis* in Pots at normal and sub-normal temperatures. Formation of humus.

IV. Organic Matter Decomposition. Turning in of Fresh Green Covers in the Field.

V. Experiments on the Effect of Turning in of Green Manures on Plant Growth.

Pot Experiments on Rates of Nitrification of Fertilisers.

First Series. A series of pots, each containing 6 kgs. of Raub High Level soil, were set up on 21.4.32. These pots were treated in duplicate with the following fertilisers:—(1) Ammonium phosphate, (2) Urea, (3) Ammonium sulphate, (4) Cyanamide, (5) Cow manure, (6) Control: 120 mg. of nitrogen was added in these forms to each pot, equivalent to a dressing of 40 lbs. of nitrogen per acre.

The pots were kept bare and leaching was carried out at irregular intervals at the rate of 40 c.c. per leaching over a period of thirty-five days.

At the end of this period, figures for the total leachings indicated that nitrification of the added fertilisers was just starting in most of the pots.

The pots treated with ammonium phosphate had given off most nitrate nitrogen in the leachings, 36 mg. compared with control pots 15 mg. This corresponds to 17.5 per cent. nitrification of the added fertiliser. Pots treated with cyanamide and cow manure appeared to have the slowest rate of nitrification.

Ammoniacal nitrogen in the leachings was low, practically negligible, ammonium phosphate pots having given off the highest amount, (1.0 mg.) and control the lowest (0.5 mg.).

When the pots were dismantled and the soil analysed, nitrate nitrogen was highest in the ammonium phosphate, sulphate and urea pots. Ammonia was similar in all.

Second Series. A series of pots was set up on 1.6.32 with similar fertilisers as in Series 1, but Castor cake was also included. Double dressings of fertilisers were given to all pots (240 mg. N_2* per pot) and heavier leaching was carried

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*In order to save space, the symbols or formulae N_2, NO_3 and NH_3 are used for nitrogen, nitrate and ammonia respectively.

out. Leaching was at the rate of about 1000 c.c. per pot every three days for the first 2½ months; subsequently, leaching was carried out once a week only.

Position at end of 44 days.

Leaching of N_2 as nitrate. Controls were lowest, giving off 174 mg. N_2, ammonium sulphate was highest yielding 276 mg. This is an increase of 102 out of 240 mg. added = 42.5 per cent. nitrification.

Castor cake, urea and ammonium phosphate had all liberated about 230 to 240 mg., cow manure and cyanamide about 200 to 210 mg.

Leaching of N_2 as ammonia. Considerable quantities of N_2 in this form were leached out. Controls gave off least, about 25 mg. per pot, varying to ammonium sulphate, the highest, 85 mg. per pot. The loss of N_2 as NH_3 from the control pots corresponds to a loss of 64 lbs. per acre per year.

Total leachings of N_2 (as NH_3 and NO_3) in the ammonium sulphate pots accounts for 102 + 60 = 162 out of 240 mg. of added N_2 = 68 per cent.

Position at the end of 5 months.

These pots were leached continually over a period of five months and finally dismantled on 13.1.33. During this period the N_2 as NH_3 sank practically to nil in the leachings in all cases, whilst the N_2 as NO_3 remained the same for all pots. Over this period the treated pots lost 140 to 150 mg. N_2 as NO_3 as against the control pots about 100 mgs.

Most of the effects, therefore, of the nitrogenous dressings were evidenced within the first period of forty-four days.

The experiment shows that under the existing conditions, nitrification hardly started until a month had elapsed and that eventually this proceeded slowly, with ammonium sulphate nitrifying at a higher rate than other manures.

It also suggests that, under fallow, unmanured conditions, losses amounting to as much as 420 lbs. per acre of N_2 as NO_3 and 60 lbs. per acre of N_2 as NH_3 may occur under heavy leaching conditions over the period of a year.

Third Series. Two series of pots were set up on 2.6.32. Each pot of one series contained 9 kgs. of jungle soil and each pot of the other series, 9 kgs. of an adjacent soil. Both soils were of the quartzite type, and had been lying fallow for some time. These soils were treated with ammonium sulphate, 360 mg. N_2 per pot, (N = 80 lbs. acre) and compared with controls.

Position at end of 42 days.

Leaching of N_2 as NO_3. At the end of this period, in the case of both soils, similar amounts of N_2 had been leached out of all pots, showing that, in this soil, nitrification had not started even after six weeks. Judging by the amount recovered from the control pots (100 mg. from 9 kgs. quartzite soil compared to 175 mg. from 6 kgs. of Raub High Level soil after the same time

in the previous experiments) the quartzite soil has a much lower rate of production of nitrate under normal conditions than Raub High Level soil.

Leaching of N_2 as NH_3. The N_2 leached out in this period shows a very great difference between controls and treated pots. The ammonium sulphate pots gave off 70—90 mg. against control of 8—16 mg.

This fact suggests, as in the previous experiments, that large quantities of nitrogen may be lost from nitrogenous fertilisers in the form of ammonium ion under fallow conditions on some soils in this country within a very short time, owing, apparently, to heavy leaching combined with a slow rate of nitrification and a low absorption capacity or retaining capacity of the soil colloids.

Position at the end of 6 months.

These leachings were continued until January, 1933, by the end of which time the total amounts of N_2 as NO_3 recovered in the leachings were as under.

		mgs.
Jungle soil + Ammonium sulphate	...	180
Jungle soil alone	...	170
Cleared soil + Ammonium sulphate	...	142
Cleared soil alone	...	150

On the other hand, the amount of N_2 as NH_3 recovered in the leachings was negligible—the value for all pots having fallen practically to nil at the end at the first six weeks and remaining there throughout.

As the difference in N_2 as NH_3 recovery at that time between controls and treated pots was 70 mg. and practically no further difference has been shown since, either in N as NH_3 or NO_3, it appears as if either 360—70 mg.—*i.e.* nearly 300 mg. of N_2 have been absorbed by the soil in some insoluble form, or else lost as gaseous nitrogen.

Loss of Nitrogen by Leaching from Pots Treated with Green Cover Crop (crotalaria usaramoensis) and Starch. The effect of Azotobacter Inoculation on Nitrogen Fixation.

A series of 24 pots was set up on 26.2.32, filled with 6 kgs. each of Raub High Level soil. Two series were arranged, limed and unlimed, half of each series being heavily inoculated with Azotobacter. Each series contained 12 pots of which four pots were treated with:—(*a*) cover crop—240 grams per pot equivalent to 40 tons per acre;—(*b*) four with starch—100 grams per pot (carbon to correspond to carbon in cover crop); (*c*) four controls.

These pots were leached weekly for the first five months, then fortnightly, at a rate of 600 c.c. of leachings per pot.

Loss of N_2 as NO_3 in Leachings. Up to a period of 20 weeks, the addition of starch depressed the leaching of N_2 completely in all cases. At the end of this period, a small amount was beginning to be recovered in the leachings.

Controls gave off a steady low amount, about 4 mg. per week on an average for the unlimed series and slightly higher for the limed series.

The pots, into which the cover had been turned, showed a sharp rise in the amounts leached out at the end of the fifth week. This was followed by a gradual decline until it reached the rate of the controls about the end of the seventh week.

The leachings from the limed plots were higher than from the unlimed.

At the end of seventeen weeks the position may be summarised as under :—

		mgs. of N_2 as NO_3 recovered in leachings		
		Limed	Unlimed	
Control	...	164	70	Inoculated
Cover	...	426	290	
Starch	...	Nil	Nil	
Control	...	116	67	Uninoculated
Cover	...	402	301	
Starch	...	Nil	Nil	

Loss of N_2 as NH_3 in Leachings. Over the period of twenty weeks, controls and starch-treated pots gave off a negligible amount of N_2 .

In the case of the pots with covers turned in, there was a sharp rise at the end of the third week which gradually declined to a negligible amount again by the end of the eighth week.

This sudden ammonia production, most probably from the readily decomposable protein matter in the green tissue, is reflected in the high rate of production of N_2 as NO_3 which was observed starting at the end of the fifth week. As on previous occasions, the limed plots liberated a larger amount of N_2 as NH_3 than the unlimed. The effect of lime would appear to be one of stimulation of the population of micro-organisms. Whether it is to be attributed to the presence of calcium ion, depression of hydrogen ion, or neutralisation of acidic toxic products is not known.

Position after 41 weeks.

Loss of N_2 as NO_3 in Leachings. As mentioned above, towards the end of twenty weeks the starch-treated pots commenced to lose N_2 in the leachings. This continued until at the end of a further period of twenty-four weeks the rate was practically the same as that of the controls. Pots treated with crotalaria still had a higher output of N_2 than the others and the effect of lime still influenced the figures slightly. No effect was attributable to inoculation.

During the period from the seventh week until the forty-first week the losses may be tabulated as under :—

		mg. N_2 as NO_3		
		Limed	Unlimed	
Control	...	91	63	Inoculated
Cover	...	141	116	
Starch	...	85	25	
Control	...	70	48	Uninoculated
Cover	...	134	111	
Starch	...	75	40	

These in combination with the previous figures for losses give totals over a period of forty-one weeks from the start as under :—

		mg. N_2 as NO_3 Limed	Unlimed	
Control	...	302	189	Inoculated
Cover	...	646	515	Inoculated
Starch	...	98	29	Inoculated
Control	...	239	155	Uninoculated
Cover	...	660	514	Uninoculated
Starch	...	82	41	Uninoculated

Loss of N_2 as NH_3 in Leachings. Over the whole period from the seventeenth to forty-first week, the amounts recovered in the leachings were negligible, in all cases the total being about 1 mg. from any one pot.

Total Nitrogen content of the Soils.

The soils in these pots started with a total nitrogen content (Kejldahl) of 0.170 per cent. At the time of the first period of seventeen weeks this had dropped to 0.105 per cent.

For those pots containing 6 kgs. of soil, this corresponds to a total difference of 3900 mg. of nitrogen.

The amounts of nitrogen leached out in the form of ammonium salts and nitrates up to this time has a maximum value of less than 500 mg.

Periodic determinations of nitrogen by the Kejldahl method were carried out on the leachings and figures obtained show an average loss of about 5 mgs. of nitrogen and 50 mg. of carbon from control and cover crop pots over a period of fifty weeks. Some of the starch pots, however, gave figures showing twenty time this amount. This point requires further investigation, especially in view of the recent theory advanced by Vageler that, in non-calcareous tropical soils, nitrogen is lost as soluble humates.

Taking the maximum amount thus lost, however, the total nitrogen losses accounted for is scarcely 50 mg. There remains, therefore, 3400 mg. of nitrogen unaccounted for. The most likely explanation of this enormous loss is that it occurs in the form of gaseous nitrogen.

This theory seems tenable especially in view of figures obtained at the end of forty-one weeks. By this time, the total nitrogen content of the pots, whilst showing slight variation between themselves, gave an average value of 0.121 per cent., showing that nitrogen recuperation was setting in. It seems likely that the aeration given to the soils in filling the pots caused heavy destruction of the organic nitrogen compounds of this soil to proceed, and that now that the soil has settled in the pots, equilibrium is once more being brought about.

Loss of Nitrogen as NO_3 and NH_3 from Pots treated with Green Cover Crop and Starch, and carrying a growth of Grass.

In view of the large losses of nitrogen obtained in Experiment II, a further extension of this was started in September, 1932. In this case, no inoculation with Azotobacter was carried out, but the pots all carried a growth of grass. In other respects the lay-out was similar. The grass was cropped periodically and the nitrogen thus removed was determined.

The experiment consisted of 12 pots of Raub High Level soil from the Government Experimental Plantation, Serdang, each containing 6 kgs. of soil. Six of these received a dressing of lime. Cross dressings were cover crop turned in, starch turned in, and controls as in the previous experiment. The fresh cover contained 1.07 per cent. N_2.

Grass was planted on 27.9.32.

In the first leachings taken on 10.10.32, very large amounts of N_2 as NH_3 were recovered from the pots treated with the cover crop—100 mg. in the case of the limed soil and 60 mg. in the unlimed. Nitrates were low. These values for N_2 as NH_3 fell gradually to practically nil at the end of eight weeks whilst the N_2 as NO_3 gradually increased. During this period, control pots and starch pots, after a preliminary small amount of N_2 as NH_3, gave nil values for nitrogen as both NO_3 and NH_3.

At the end of fifteen weeks these conditions still obtained.

This shows quite clearly and definitely, therefore, that the presence of a growing cover enables all N_2 as NO_3 to be absorbed under normal conditions and that, although after a dressing of green manure there is such a rapid decomposition of readily soluble proteins that quantities of ammonia may escape by leachings, the crop soon reduces this excess. As was expected, the crops of grass reaped were best on the cover-treated pots and worst on the starch—the activities of the organisms in decomposing this rendering all nitrate unavailable for the growing plant.

The relative crops produced may be seen from a comparison of the N_2 figures for the grass-croped. The percentage N_2 in the grass was practically the same for all pots.

Total mg. N_2 recovered in crops at end of 15 weeks
(Averages)

		Limed	Unlimed
Control	...	180	122
Cover	...	660	650
Starch	...	94	80

mg. N_2 as NO_3 recovered in leachings.

		Limed	Unlimed
Control	...	16	11
Cover	...	78	65
Starch	...	Nil	Nil

mg. N_2 as NH_3 recovered in leachings.

		Limed	Unlimed
Control	...	16	16
Cover	...	153	140
Starch	...	3	3

The sudden rise and fall in ammonia figures and the manner in which nitrate is absorbed by the growing plant is best shewn by the following tables :—

mg. N_2 as NH_3 recovered in leachings.

Treatment	10 — 10.32	10 — 24.32	11 — 7.32	11 — 21.32	12 — 5.32	12 — 19.32	1 — 9.33
Control	11.5	1.1	0.3	0.3	0.4	Nil	0.2
Control	13.8	3.3	0.3	0.3	0.2	Nil	0.2
Cover	92.0	51.75	2.3	0.8	0.1	Nil	0.2
Cover	103.5	51.75	3.4	0.8	Nil	Nil	0.2
Starch	2.3	1.1	0.4	0.2	0.1	Nil	0.3
Starch	1.1	0.6	0.3	0.3	Nil	Nil	Nil

mg. N_2 as NO_3 recovered in leachings.

Treatment	10 — 10.32	10 — 24.32	11 — 7.32	11 — 21.32	12 — 5.32	12 — 19.32	1 — 9.33
Control	16.5	Nil	Nil	Nil	Nil	Nil	Nil
Control	16.5	3.3	Nil	Nil	Nil	Nil	Nil
Cover	2.8	20.7	20.7	20.7	6.7	5.6	Nil
Cover	2.8	13.8	20.7	20.7	11.1	9.2	Nil
Starch	Nil	0.5	Nil	Nil	Nil	Nil	Nil
Starch	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Decomposition of Crotalaria Usaramoensis in Pots at Normal and Sub-normal Temperatures. Formation of Humus.

On 31.3.32, 12 pots were set up, each containing 28 kgs. of Raub High Level soil. 560 gms. of fresh Crotalaria were turned in to each pot, corresponding to a field dressing of 20 tons per acre. 6 pots were limed at the rate

of 2 tons per acre—6 unlimed. 2 pots, one limed and one unlimed, were set aside under normal temperature conditions and kept water-logged.

2 limed and 2 unlimed pots were placed in a 'cold storage' box at an average temperature of 75°F—the remaining pots were exposed in the open.

All the pots (excepting those water-logged) were leached weekly to about 600 c.c. and N_2 as NH_3 and NO_3 determined in the leachings. The fresh cover turned in contained 1.2 per cent. nitrogen.

Nitrogen as NO_3 and NH_3 recovered in Leachings.
Position at end of 15 weeks.

	N_2 as	Limed	Unlimed
Normal Temperature	Nitrates	770 mg.	485 mg.
	Ammonia	17 mg.	70 mg.
		787 mg.	555 mg.
Sub-normal Temperature	Nitrates	87	89
	Ammonia	85	118
		172	207

It is assumed that decomposition in the unlimed pots at normal temperature is proceeding in a normal manner. At normal temperatures, therefore, the effect of lime has been to increase the liberation of N_2 as NO_3 and to depress the amount of N_2 as NH_3. This indicates a very rapid change of nitrogen from the protein form to the nitrate form.

At sub-normal temperatures, it would appear that the activity of the nitrifying bacteria has been reduced practically to a standstill: hence we can look for no effect from liming and no effect is in evidence. The figures for total N_2 recovered, (172 mg.) compared with 787 mg. or 555 mg. with 207 mg., indicate to what extent microbiological activity has been curtailed.

The ammonia nitrogen recovered is higher in the pots at sub-normal temperature, but this does not indicate any greater activity of the ammonifying bacteria, since the low figures for the normal pots are merely an indication of the rapid change to nitrate.

At the end of this period (fifteen weeks) nitrate was commencing to be liberated from the pots kept at reduced temperature, which would show that the inhibiting effect on the microbiological life was beginning to wear off and that the population was becoming acclimatised to the new environmental conditions.

Over the period of the next sixteen weeks, the leachings given off by these pots were as tabulated beneath.

	N_2 as	Limed	Unlimed
Normal Temperature	Nitrates	460 mg.	455 mg.
	Ammonia	Nil	Nil
		460 mg.	455 mg.
Sub-normal Temperature	Nitrates	370	368
	Ammonia	40	45
		410	413

As was anticipated, the amount of N_2 as NO_3 from the pots at reduced temperature gradually increased until the figures were practically the same as those for the normal temperature pots, showing that the microbiological life had become acclimatised to the new conditions.

The effect of the lime dressing would appear to have worn off completely.

It is interesting to note that slight ammoniacal nitrogen losses persist in the soils at lower temperature, but the total loss of nitrogen over the period is approximately the same for all pots.

At the end of this period—thirty-one weeks from the start—a fresh dressing of *Crotalaria usaramoensis* was turned into the pots at the lower temperature, followed six weeks later by a fresh dressing into the pots at normal temperature.

No immediate effect of these dressings became apparent in the case of pots at sub-normal temperatures, as reflected by the figures for nitrogen in the leachings, and at the end of the period under review (forty-three weeks) the amounts of N_2 as NO_3 and NH_3 were similar to those obtained towards the end of the thirtieth week.

In the case of the pots at normal temperature, increased nitrate nitrogen figures were obtained starting about six weeks after turning in of the cover.

Humus Determinations.

Humus determinations carried out at intervals over this period showed small fluctuations in the quantities of alpha humus extracted. Figures for beta humus, however, showed a steady slight upward trend as is indicated by the table on page 16.

Organic Matter Decomposition: Turning in of Fresh Green Covers in the Field.

Plots at the Government Experimental Plantation, Serdang, growing the following covers, were utilised for this experiment :—

(*a*) Mixed legumes—*Pueraria phaseolus* and *Centrosema pubescens.*

(*b*) Upright legume—*Tephrosia toxicana.*

(*c*) Non-legume—*Mikania scandens.*

(*d*) Bare.

Quantities in grams of beta humus extracted from 50 gms. dry soil

	Start 30.3.32	21.4.32	23.5.32	22.8.32	4.10.32
Normal Temperatures					
Limed	5.35	6.25	7.05	7.2	6.9
Unlimed	5.35	6.45	6.3	6.6	7.3
Sub-normal					
Limed	5.22	6.6	6.3	6.72	6.95
Unlimed	5.22	5.8	6.25	6.8	7.1

All plots were divided longitudinally into two, and one half of each was allowed to remain untouched. In the case of (*a*) and (*c*), the cover on the other half was cut and turned in. In the case of (*b*), the cover was not cut but the ground was cultivated, and in the case of (*d*) it was forked.

Circular glazed earthenware pots about 1 ft. deep and of similar diameter were sunk flush with the ground in the centre of each sub-plot and a wire cage containing about 6 in. of the top soil was placed in the top of each pot in order that the leachings might be collected.

Soil thermometers were sunk in both halves of plots (*a*) and the untouched half of plot (*d*).

The following analyses and determinations were carried out at weekly intervals on samples from each of the 8 sub-plots :—

On the soil :

Moisture
Nitrate
Ammonia
Total Carbon and Nitrogen
A and B humus
Carbon and Nitrogen content of each humus and loss on ignition
Residual Carbon and Nitrogen from alkali extract.

On the leachings.

Volume; pH; N_2 as NO_3.

Temperatures were recorded at 6 in. depth daily.

Preliminary analyses of the soil were carried out just previous to turning in of the cover crops. The cover crops themselves were also analysed, and gave the following results :—

Percentage Composition oven dry basis.

		Mixed Legumes	Non-Legume
Ether soluble	...	3.42	6.6
Water soluble	...	17.50	26.8
Alcohol soluble	...	3.03	3.9
Hemi-celluloses	...	15.40	12.0
Celluloses	...	19.60	12.1
Lignin	...	12.60	11.5
Water insoluble protein	...	13.40	12.25
Total Ash	...	6.70	10.25
		91.65	95.40
Total Carbon	...	47.9	45.3
Total Nitrogen	...	3.22	2.62
Ratio C/N	...	15 : 1	18 : 1
Fresh Materials.			
Moisture	...	66.93	85.31
Loss on Ignition	...	30.85	13.18
Ash	...	2.22	1.51
		100.00	100.00
Total Carbon	...	15.81	6.67
Total Nitrogen	...	1.06	0.385

These covers were turned in on 27.11.31 at the estimated rate of 1000 lbs. per acre on Plot (*a*) and 3000 lbs. per acre on Plot (*c*). As each sub-plot was $\frac{1}{30}$th. acre, the amounts added were 130 lbs. and 400 lbs. respectively. Analyses were carried out for a period of 7 weeks.

Results.

(1) *Soil Temperatures at 6 ins. below the Surface.* Soil temperatures over a period of twenty-eight days ranged from 80°F to 83°F on the bare plot (*d*). On plot (*a*) on the half into which the cover had been turned, the range was from 79° to 82°F; in practically all cases being 1° lower than the bare plot on any occasion. On the half on which the cover was still growing, the range was from 78° to 80°F—this again on any occasion being 1° lower than the other half of the plot and 2° lower than the bare plot.

A fall of 2 ins. rain in one day, the maximum which fell over the period, produced an effective drop of temperature of 1° only on all of the plots.

(2) *Nitrates and Ammonia in the Soil.* In the case of all eight sub-plots, ammonia in the soil showed very small variation over the period of seven weeks,

remaining throughout in every instance between 8 and 12 parts per million (p.p.m.).

In the case of the untouched halves of every plot, nitrates remained practically constant, varying from 0.0—1 p.p.m., except for the bare plot which, starting with nitrate content of 5 p.p.m., rose to 10 p.p.m. and fell again.

In the case of the treated halves of the plots in plots (*b*), (*c*) and (*d*) there was a steady rise in all cases from 0.0 p.p.m. to about 4 p.p.m. after a period of three weeks which died away to nil again at the end of seven weeks.

Only in the case of the mixed legumes turned in was there any marked rise in nitrate content; on this sub-plot, the nitrate figures rose sharply from nil to 20 p.p.m. after three weeks and continued at this height for the next four weeks.

(3) *A Humus.* This portion of the humus fraction fluctuated slightly in amount over the period, but the general trend appeared to be a loss during the first two or three weeks on the plots into which green cover had been turned, (*a*) and (*c*), and was more particularly noted on plot (*c*)—the non-legume. This initial drop was followed by a rise again until at the end of seven weeks the original level had been regained.

The composition of the product A humus remained constant.

(4) *B Humus.* The figures obtained for the amounts of B humus fluctuated wildly from week to week, but it might be suggested from them that there was a rise in value where cover had been turned in after about the end of the fourth week.

The extent of the fluctuations, however, is too great for any definite conclusion to be drawn from the figures.

(5) *Total Carbon and Nitrogen.* The figures for total carbon and nitrogen fluctuated throughout the period, but there were no definite signs of either a loss or gain in total nitrogen or carbon. This is only to be expected when consideration is paid to the small amounts of green matter added.

It is noteworthy that these figures for the bare plot, both before the experiment began and throughout, are lower for carbon than the figures for those plots which had had cover growing in them for some seasons; the amount is small but definite. Cover crop plots contain about 1.8 to 2.0 per cent. carbon and the bare plot 1.5 to 1.8 per cent. carbon.

This experiment was continued throughout 1932, occasional samples being taken for analysis. At the start of the wet season, the existing covers were turned in and fresh seed planted. Analyses, up to the present date, indicate that there is possibly a very small increase occurring in the amount of A humus extracted from the soils in which covers have been turned in. It is difficult to cite individual figures, as fluctuations within wide limits occur, but the trend may exist.

Total carbon and nitrogen figures, for samples taken throughout the year, show a very considerable drop in the month of April followed by subsequent rises and falls. These fluctuations occur in all the soils. The maximum drop

in nitrogen content is from 160 mg. per 100 gr. to 60 mg. per 100 gm. and indicates large losses of gaseous nitrogen.

This point is subsequently further discussed.

Experiments on the Effect of Turning in of Green Manures on Plant Growth.

A. A series of 12 pots were set up in February, 1932, each containing 6 kgs. of Raub High Level soil. At weekly intervals, 1 per cent. by weight of *Crotalaria usaramoensis* leaves (10 tons/acre) were added to individual pots. One week after the addition to the twelfth pot, maize was planted in all, together with a basic dressing of basic slag (50 lbs./acre P_2O_5).

Owing to inferior seed, germination failed, but the pots were successfully replanted a week later.

The growth of the maize was best in the pots in which the green manure had been turned in, one to four weeks prior to planting.

It would appear that more beneficial effects are derived by planting up within a short time of turning in a cover crop, rather than by allowing the green material to rot down.

B. Further, to test the conclusion reached in the previous experiment, 6 pots of Serdang Black soil were used to compare the effect on growth of rotted grass and fresh grass turned into the soil.

Two pots were treated with a dressing of well-rotted grass, two with fresh grass and two controls.

Maize was planted, and the subsequent growth observed. The difference in growth was very marked and further substantiates the conclusion reached previously that fresh green matter turned into the soil exerts its greatest beneficial effect if planting takes place almost immediately.

C. An experiment was started in October 1932, to compare the fertility of jungle soils and cleared soils, and to determine the influence of jungle mulch.

6 pots were set up containing 24 kgs. each of fresh quartzite jungle soil, and 6 pots containing 24 kgs. of quartzite soil which had been cleared of jungle for some years. To three pots of each series was added about 1½ kgs. of fresh jungle mulch, laid on the top of the soil in imitation of jungle conditions. The remaining 3 pots of each series remained with a cleared surface.

Subsequent growth of maize was best in all the pots with the jungle mulch added, the jungle soil with the jungle mulch being very slightly better than the other soil with jungle mulch.

Maize in the pots without mulch, whether on jungle or cleared soil, made markedly worse growth.

From this experiment it would appear that the fertility of fresh jungle soils is due in some manner to its covering mulch rather than any particular property of the soil *per se*. This effect of mulch may be due to its protective

action on the soil, or to nutrient material liberated on breakdown or, in practice, on burning.

D. In order to test out this conclusion, a further experiment was devised in which the effect of this jungle mulch could be determined. In combination with this, information was sought on the effect of 'burn' on soil.

A series of 30 pots, the treatments in triplicate, was set up with quartzite soil.

The treatments were as follows :—

1. Top 3 ins. of soil heated to 75°C.
2. do. do. 100°C.
3. do. do. 150°C.
4. do. do. 200°C.
5. do. do. 250°C.
6. do. do. 300°C.
7. do. do. 350°C.
8. do. do. 400°C.
9. Soil covered with 2 ins. of artificial mulch of torn paper.
10. Soil covered with burnt forest mulch.

It was hoped that this would indicate whether the beneficial effect of jungle mulch was due to its protective action or its chemical composition, and further, in the case of a burn, whether or not the action was one of partial sterilisation of the soil.

The pots were planted with maize and at the end of six weeks the position was as follows. The maize in treatment 10 had made best growth—closely followed by treatment 9. Treatments 5—8 were very much inferior whilst treatments 1—4 were slightly better than this, but not as good as treatments 9 or 10. Growth in all cases, however, was bad and the plants were weedy and straggly, although originally they showed much greater promise.

This experiment indicates that the effect of jungle mulch is probably both protective and chemical and that the main effect of a burn is one of liberation of chemical products for plant nutrition rather than partial sterilisation. Growth was, however, so poor that further work is required before definite conclusions can be drawn.

General Considerations.

The Nitrogen Problem.

Total Nitrogen Content of Soils.

In the latest of a series of papers on nitrogen recuperation in the soils of the Bombay Presidency, Sahasrabuddhe and Kanitkar* have summarised their views to date on the results of their experiments and state that definite recuperation of nitrogen takes place in these soils under field conditions; that

* *Indian Journal of Agricultural Science*, Volume II, Part V, October, 1932.

the addition of organic matter in the form of farmyard manure or green manure increases the recuperative power of the soil, and that, over a period of one year, from month to month the nitrogen content of the soil is not a stable or a constant quantity. With regard to these conclusions, it should be pointed out that the soils they are dealing with have an average nitrogen content of about 100 mg./100 gm. soil or 0.010 per cent. N_2—and that their findings are based on analytical data which are obtained from 20 grams of air dry soil by means of Kejldahl determinations.

Experiments in this laboratory on 5 gms. samples of air dry soil indicate that a single Kejldahl determination of the N_2 content of an air dry soil is liable to a 10 per cent. sampling error. A mean of duplicates, therefore, will have an error of about 7 per cent. Some of the conclusions reached in their earlier paper are based upon differences in nitrogen content which lie within this error.

The results of their month to month determination of total nitrogen, however, show much greater nitrogen variation than could possibly be accounted for by experimental or sampling error, the range of fluctuation being from 70 to 130 mg. of N_2 per 100 gm. soil.

The conclusion that the total nitrogen content of soils is not a stable or a constant quantity is borne out by the results of these pot experiments on the loss of nitrogen by leaching and also by the figures obtained in the field from Block XIV at Serdang. Here spasmodic sampling showed a drop of from 170 to 60 mg. per 100 gm. soil in these plots during the period January to April 1932—with a subsequent rise and final figure at the end of the year of about 100 mg. per 100 gms. soil.

Ignoring the possibility of sampling error, results have been obtained which would also support the further conclusion, that the addition of a green manure has aided the recuperative power of the soil.

However, these results, in combination with accidental observations obtained from experiments designed for other purposes, all tend to show that the total nitrogen content of Malayan soil is subject to great fluctuation.

Many Malayan soils contain nearly as much nitrogen and carbon in the sub-soil as in the top soil.

The evidence from pot experiments has shown that, undoubtedly, soluble nitrogen and carbon is being washed through. Vageler has suggested that, in non-calcareous tropical soils, nitrogen may be lost as soluble humate. It is a reasonable hypothesis, therefore, that the high nitrogen and carbon content of some sub-soils may be due to the gradual storage by long accumulation from these soluble humates being washed downwards.

But, as has been pointed out previously, the fluctuations which have been found to occur in total nitrogen content are far too great to be accounted for by loss as soluble humate.

One is forced to the conclusion that these enormous losses are mainly in the form of gaseous nitrogen. To counteract these losses, however, large

recoveries are taking place, producing the fluctuations observed. This can only mean that rapid fixation is occurring at certain seasons.

Mr. R. A. Altson, Assistant Mycologist of this Department, has isolated Azotobacter from typical Malayan soils, and has shown that such isolations are capable of fixing nitrogen in culture; and though it has not yet been demonstrated that this function is performed in the soil, it is possible that any fixation which may have taken place in the experiments so far conducted has been masked by rapid denitrification. Clostridium was found to be present in most of the soils which he examined.

Nitrogen as Nitrate and Ammonia.

An examination of the literature on laboratory experiments bearing on the problem of nitrification in soils has shown that, in the majority of instances, the dressings of nitrogenous fertilisers added have been excessively heavy, and in few cases only has the rate of application being comparable with field dressings—*i.e.* a rate of 1—2 cwt. per acre of fertiliser equivalent to say 40 lbs. nitrogen per acre.

Excessively heavy dressings are liable to upset the normal sequence of changes which would occur in the field and as a consequence, therefore, experiments as carried out in this laboratory have all been with normal rates of application of manures.

Unfortunately, this means that natural fluctuation and experimental errors are comparable with the effects to be looked for from any nitrogenous dressing—and some experiments have, in consequence, given negative results.

One or two definite indications, however, have emerged. It would appear that maximum nitrate nitrogen accumulation occurs at a period of four to six weeks after application of a dressing; further, if any excess of nitrogen occurs in the soil as ammonia, this is very liable to be lost in drainage instead of being held by the colloidal complexes in the soil as has been shown to occur in other countries.

The Organic Matter Problem.

In view of the remarks so frequently read and heard in Malaya, that the turning in of a green manure into the soil increases the 'humus' of the soil, (with no definite indications of what is meant by humus), experiments have been carried out to determine, as far as possible, what is the fate of covers turned into soils, and what their effect is on the soils.

Conditions in Malaya are practically ideal for the complete and rapid oxidation of organic matter to carbon dioxide, ammonia and water by micro-organisms, there being a high temperature and plenty of moisture, although admittedly calcium carbonate is lacking.

In addition to this process of complete oxidation to carbon dioxide, ammonia and water, there exists in nature the process of humification whereby some part

of the added organic matter is not completely destroyed, but survives in an altered form as a dark-coloured amorphous material which is known as humus.

Humification may occur in three ways —

(1) Anaerobic humification
(2) Acid humification
(3) Humification under semi-arid condition.

Anaerobic humification occurs in ponds and lakes under water-logged conditions and it is this type of humification which probably accounts for the belts of coastal peat formed in Malaya.

Acid humification occurs where organic matter is decomposing in the absence of calcium and other bases, as is exemplified by the production of acid peat under heath or conifer forest conditions. In this case, the peaty organic matter accumulates as a sharply defined layer at the surface. The peat found in patches on the hills of Malaya may have been formed in this manner.

Humification under semi-arid conditions, as is exemplified by the black earth soils of Russia, occurs where there is a deficient rainfall but a high content of calcium and other bases which prevents the formation of an acid peat.

On the plains of Malaya, on free draining soils—which are in the majority—none of these three conditions are satisfied. The position we reach, therefore, is that no conditions exist which are known to be suitable to the formation of humus and that conditions are practically ideal for the rapid and complete destruction of organic matter to carbon dioxide and water. The natural inference therefore is that no humus will be formed in these soils.

In practice, it is found that a normal inland soil of Malaya of the quartzite or granite type has a total organic matter content of about 6 per cent. as compared with figures for English soils of from 10 per cent. to 20 per cent. This being the total organic matter content, the possible amount of humus present is very small indeed.

The results of experiments described this year have shown that where covers have been turned into the soil, the amount of humus (alpha and beta) subsequently extracted shows no real increase.

It is clear that there is no lack of microbiological life in Malayan soils since, even in the absence of added organic material, nitrification proceeds normally, and as has been mentioned, at times rapid fixation must occur.

Green matter added to Malayan soils clearly, therefore, does not fulfil its usual role in the formation of humus. It is possible, however, that humus may be formed, and, according to Vageler's theories, be immediately lost in soluble form in the drainage waters; but there appears a more likely explanation.

If we examine the results obtained in this experimental work, it will be noted that the turning in of green manures has been accompanied in all cases by a great stimulation of growth. Observations have shown that immediately after turning in, rapid production of ammoniacal and nitrate nitrogen occurs, extending over a period of six to eight weeks, and that this production is

absorbed by growing plants. It seems abundantly clear, therefore, that intensive and rapid destruction of the organic material is taking place with the liberation of carbon dioxide, water and ammonia and that this destruction extends to practically the whole of the plant tissues, the amount of humus formed being negligible.

Herein, too, possibly lies the explanation of the fact that plants thrive best if green matter is turned in only shortly before planting. The view is usually held that the turning in of a green manure immediately prior to planting is disadvantageous because the rapid decomposition of the excess of carbohydrates which takes place uses all the reserves of nitrogen from the soil so that none is available for the plant. So far from this being the case, the experiments carried out under fallow conditions show that there is actually an excess of ammoniacal nitrogen liberated in the soil. Under non-fallow conditions, this ammoniacal nitrogen is rapidly changed to nitrate nitrogen and hence is of immediate benefit to the plant. The plant receives the benefit of a good nitrate supply at an early stage of growth: this lasts as long as there is readily decomposable protein matter still extant in the cover turned in.

Further, it must not be forgotten that this rapid destruction is accompanied by a large evolution of carbon dioxide and there is evidence from numerous workers of this constituting a form of fertilization.

There remains, however, a point raised in Part II of this series. Why should the benefits conferred outlast the period of rapid decomposition if these benefits are attributable only to the nitrate supply and possibly the fertilization value of carbon dioxide? Two suggestions are there mentioned, either that the formation of iron humate renders iron available, or that an increase of available nutrients is obtained by the acceleration of mineral decomposition.

These questions and suggestions in themselves indicate the lines along which future work will be directed.

MUSHROOM GROWING IN PROVINCE WELLESLEY & PENANG

BY

J. A. Baker,

Agricultural Field Officer, Province Wellesley and Penang.

The cultivation of mushrooms is a recent innovation in the Malay Peninsula though it is said to be practised fairly extensively in Netherlands India. The initiative in Malaya was taken by a few Chinese in Penang who introduced spawn from China in April 1932 and have since carried on a small, though profitable industry, at Sungei Nibong and at Genting. A trial mushroom bed was started at Bukit Merah Padi Test Station in May 1933, and the results so far obtained have been encouraging.

The fungus in question was identified by the Mycologist as *Volvaria volvaceae,* which is the principal species cultivated in Netherlands India. It is a large pileate fungus with a dark grey-coloured cap, some three inches in diameter when fully expanded. It appears as a small "button" completely surrounded by a rather thick volva which persists until the fungus is about one-third its full size. It has no annulus. Figure 1.

For purposes of cultvation, the only essential factors are an abundance of padi straw and an adequate supply of water. The straw needs to be spread out and carefully picked over, all the leaves being removed, so that only the haulms remain. These are then made into small bundles or sheaves and are soaked in water for two days. While they are soaking they should be trodden from time to time to render them soft and pliable. A low earth bed (say 16 feet x 3½ feet) is then constructed to a height of twelve inches and a layer of spawn is distributed evenly around the edges. Over the spawn, sheaves of straw are laid crossways to form a continuous layer. The length of the straw is usually such that one end must be bent back so that the haulms fit the breadth of the bed. When the next layer is applied the opposite ends are bent in the same way so that the surface remains approximately level.

The third layer of sheaves is laid lengthwise, instead of crosswise, and water is poured over the surface. The mass is then pressed down, to consolidate it as far as possible, and another layer of spawn applied. This process is repeated. After the third application of spawn, the same arrangement is followed, with the addition of a kind of thatch, in which the sheaves are made to slope upwards towards the middle, and the bed is completed by spreading a thin layer of haulms right over it from side to side.

Copious supplies of water must be given with the construction of each successive layer. Such a bed would be about four feet high (though it subsides somewhat with age) and would present in section, the appearance shown in Fig. 2.

It is convenient to surround the bed by a shallow ditch from which water can be readily obtained later. For a bed of 16 ft. x 3½ ft. x 4 ft. one bag of spawn containing twenty-five gantangs (Imperial gallons) is regarded as sufficient.

According to Chinese growers, no further watering should be done for a week after the spawn has been sown, though the validity of this statement remains to be tested. At the end of this period, however, water must be poured over the bed twice daily, morning and afternoon.

At Bukit Merah, the first mushrooms were harvested 25 days after the spawn had been sown. Their appearance followed two days of heavy rainfall.

Under favourable conditions 1—2 kati* of fresh mushrooms per day may be obtained from a bed of the dimensions given above, though periods of dry weather reduce the yield or, if prolonged, may suspend it altogether until there is further rainfall. In this connexion, it may be noted that watering, as ordinarily practised, does not appear to offer an effective substitute for rainfall though it would presumably do so if the water were applied in sufficient quantity or over a sufficient period of time. After a few weeks, the internal temperature of the bed is about 45°C at six inches from the surface and 50°C at a depth of one foot. Later the temperature gradually decreases.

The mushrooms are preferably picked in the "button" state (*i.e.*, before the volva has broken) and eaten fresh. If, however, it is desired to keep them they may be dried over a charcoal fire. For this purpose, the apparatus shown in Figure 5 is used. It consists simply of a broad basketwork cylinder made from bamboo, within which a removable platform of the same material is supported by two horizontal wires fixed at right angles across the cylinder. The charcoal fire is made in an iron pan and placed under the platform. The drying process takes about twelve hours.

When fully dried, the mushrooms may be kept almost indefinitely provided that they are stored in air-tight tins, such as that shown in Figure 6. If the tin is not air-tight, the mushrooms tend to acquire a rather unpleasant smell which, however, disappears to a large extent on cooking. Eight to nine kati of fresh mushrooms will give one kati of the dried product.

The time which should elapse before a bed should be broken up is, to a certain extent, a matter of discretion. The important point is that the whole mass of straw should be permeated by the mycelium so that it can be used as spawn for the establishment of new beds. Three months from the date of sowing is regarded as a suitable age for this. A bed of 16 ft. x 3½ ft. x 4 ft. may be expected to yield about ten bags of spawn which are sufficient for the establishment of ten new beds. If sufficient straw is not available for the construction of new beds, the spawn should be dried in the sun and stored in sacks for the next season. It is stated, however, that the viability of the spawn

*1 kati = 1⅓ lbs.

Fig. 1. Volvaria volvaceae—Fully expanded.

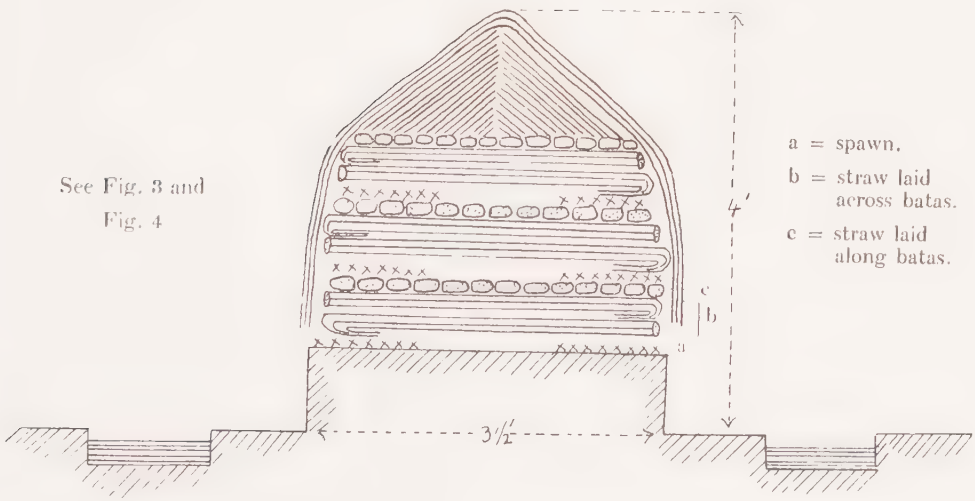

Fig. 3. Mushroom Bed—Earth Bed before straw has been laid.

Fig. 4. Finished bed.

diminishes if it kept too long and that it is preferable to establish a series of new beds whenever the old ones are broken up. At the same time, old rotted straw is not regarded as suitable so that, if the mycelium is to be retained active throughout the year, provision must be made for the proper storage of large supplies of straw.

The usual market prices for mushrooms in Penang are as follows :—

Dried	...	$1.20 — $1.50 per kati.
Fresh	...	0.30 — 0.35 „

As eight to nine kati of fresh mushrooms yield only one kati of dried mushrooms, it is usually more profitable to sell them in the fresh state, and only those which are unsellable are dried.

In districts where padi straw is readily available, mushroom cultivation would seem to have several points in its favour, namely :—

(*a*) no materials are necessary except straw and water,

(*b*) the only capital expenditure required is the initial purchase of spawn,

(*c*) although the beds require constant attention, the work is in no way laborious and would not occupy more than an hour or two every day,

(*d*) in so far as there is apparently a wide market for mushrooms, the occupation would probably be very profitable.

With regard to (*b*) it may be remarked that there is no reason why spawn should not be made available at very much lower prices than at present. At the time of writing, the industry is exclusively in the hands of a few growers in Penang who require $4 for a bag of spawn. This price could almost certainly be very greatly reduced.

As regards (*d*) it may be noted that the demand in Penang greatly exceeds the supply and that, in order to purchase fresh mushrooms, it is necessary to to visit the market early in the morning. Later in the day the stock is sold out. The consumption, it is true, is chiefly by Chinese, but enquiry shows that Malays are also fond of mushrooms though they ordinarily eat wild species only. Flavour is not likely to present a difficulty and *Volvaria,* in fact, resembles the English mushroom very closely in flavour.

There remains also the possibility of exporting dried mushrooms from padi areas (where alone their cultivation could be profitably undertaken) to areas in which padi is not grown. It is probable, therefore, that mushroom growing would form a profitable accessory industry to padi cultivation, in much the same way as does fish-rearing at present.

Summary.

1. The cultivation of the edible mushroom—*Volvaria volvaceae*—on padi straw is described.

2. Yields of one to two kati of fresh mushrooms per day may be obtained during the season, from a bed 16 ft. long, 3½ ft. wide and 4 ft. high.

When such a bed is broken up, spawn, sufficient for the establishment of 10 new beds, can be obtained.

3. A description of a method of drying fresh mushrooms over a charcoal fire is given. It is found that eight or nine kati of fresh mushrooms will be required to produce one kati of dried mushrooms.

4. The usual market prices for mushrooms in Penang are $1.20 to $1.50 per kati for dried and 30 cents to 35 cents per kati for fresh mushrooms.

At present the demand in Penang exceeds the supply.

5. It is considered that mushroom growing could form a profitable accessory industry to padi cultivation, since the only materials required are padi straw, water and spawn; the work is not laborious and there is a ready market for the produce.

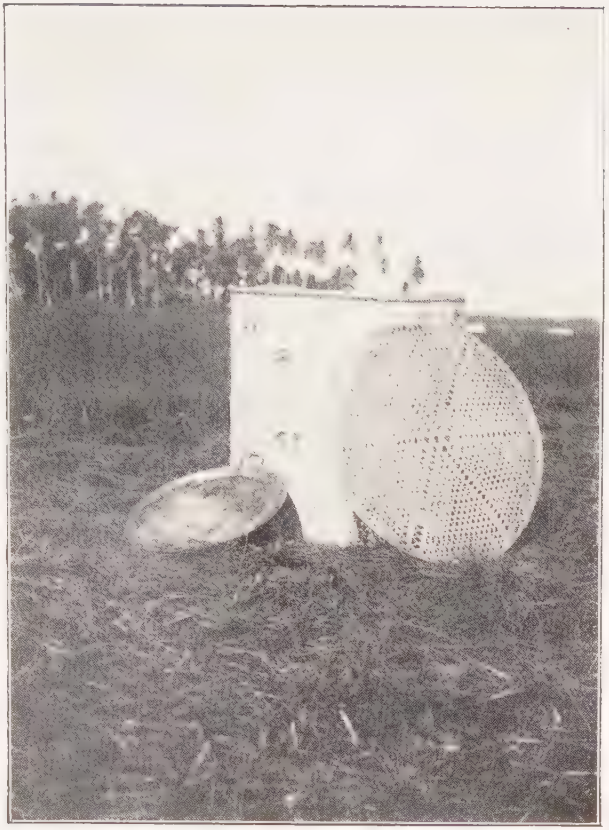

Fig. 5. Apparatus used for drying Mushrooms.

Fig. 6. Air-tight tin suitable for storing Mushrooms

THE OIL PALM IN SUMATRA

BY

J. N. MILSUM,

Senior Assistant Agriculturist.

Introductory.

In the following article it is proposed to record observations made during a visit to the East Coast of Sumatra in May, 1933. A number of estates were visited with the object of ascertaining recent advances in oil palm production in that country. Since the cultivation of this crop is now on an established basis in Malaya, the more important points of interest only are recorded.

Area under Cultivation and Production.

The planted area of oil palms in Sumatra at the end of 1932 is shown as 155,000 acres, of which 97,120 acres were in bearing. The acreage under oil palms in Malaya at the end of 1932 was 61,025 acres.

Exports of oil palm products during the years 1931 and 1932 for Sumatra and Malaya respectively are as shown in the following tables :—

Exports of Oil Palm Products from Sumatra.

Year	Palm Oil.		Palm Kernels.		Total Value of net exports. F.
	Quantity Tons.	Value F.	Quantity Tons	Value F.	
1931	60,420	12,084,241	11,996	1,092,149	13,176,390
1932	83,633	11,843,769	17,586	1,190,065	13,033,834

Average exchange value during 1931 $100 = F. 139.
1932 $100 = F. 98.

Exports of Oil Palm Products from Malaya.

Year	Palm Oil.		Palm Kernels.		Total value of net exports $
	Quantity Tons.	Value $	Quantity Tons.	Value $	
1931	4,575	1,011,610	727	112,093	1,123,703
1932	7,892	1,136,841	1,248	162,695	1,299,536

Returns from the East Coast of Sumatra and Acheen for the year 1932 were 98,036,317 kilos palm oil and kernels from a productive area of 39,321 hectares. This represents a return of oil and kernels amounting to 2,493 kilos per hectare. On a basis of 20 per cent. kernels to oil in production, it will be seen that approximately 2,000 kilos oil and 500 kilos kernels were obtained. This represents yields of 1,784 lbs. oil and 446 lbs. kernels per acre from the area in production. These figures agree closely with the estimated figures of crop returns for an estate in full bearing, published in Bulletin No. 39, Department of Agriculture, S.S. and F.M.S. (1927), page 79; *viz.* 16 cwts. (1,792 lbs.) palm oil and 4 cwts. (448 lbs.) kernels per acre.

Seed Germination and Nurseries.

In general estate practice, seeds are sown in sand beds in damp situations. Higher germination is obtained in beds exposed to full sunlight than those in the shade. Germination is less rapid during the rainy season than during dry weather, owing to the sand beds remaining in a damp condition and developing less heat from lack of sunlight. The usual germination obtained is 80 per cent. within five to six months from sowing. Experiments have shown that immersing seeds for two days in a 1 per cent. solution of hydrochloric acid and rinsing for two days in running water, results in a considerably increased rate of germination.

Seedlings are transplanted from the seed beds when they show two leaves. The land selected for this purpose is always, as far as possible, in a sheltered position with moist fertile soil.

It may be mentioned here that very considerable importance is attached in Sumatra to planting new areas with palms raised from seed of known parentage. The General Experiment Station of the A.V.R.O.S., in conjunction with a number of estates, have paid particular attention to this subject. An adequate supply of such planting material is available, and results to-date thoroughly justify the care taken in this connexion.

Planting.

Palms are generally planted in the field when one year old. The usual planting distance is 9 metres by 9 metres (29.5 ft. by 29.5 ft.) triangular and, although slightly closer planting was seen, the wider spacing is generally undertaken. On hilly land, a planting distance of 9 by 6 metres (29.5 ft. by 19.7 ft.) is sometimes employed. On such land, planting on contour is considered advisable for the purpose of facilitating harvesting operations.

Upkeep of Plantation.

The use of cover crops throughout all planted areas is general and, by a system of selective weeding, it is possible to keep weeding costs at a very low figure. In new clearings four rows of lamtoro, *Leucaena glauca,* are sown

between the rows of young palms. The lamtoro is cut back to 2 feet from ground level when 9 to 12 months old and subsequently slashed every six months. A mixture of *Centrosema pubescens* and *Pueraria javanica* seeds are sown between the rows of lamtoro and allowed to climb over the latter. In course of time the two low-growing cover plants smother out the lamtoro, which dies down and forms a layer of surface humus. This combination of erect and creeping leguminous plants in new clearings appears most effective and several large areas so treated were seen.

In low-lying fields, peria (*Momordica charantia*) is frequently used as a cover plant and makes very even growth in such situations. This cover crop is gaining in popularity since it is of rapid growth and when once established prevents growth of all weeds.

In all clearings, a space of 5 feet radius is kept clean-weeded round the base of the palms. As the palms mature, these spaces are connected up and strip weeding is undertaken, with the object of allowing freedom of movement in harvesting.

On the edges of fields, or in other situations where the growth of cover plants is slow, the legumes are encouraged to ramble by the provision of twigs and palm leaves. The excellent growth of the several cover crops seen, is due undoubtedly, to the regular use of fertilizers. Hand-weeding is generally practised with the object of not stirring the soil, since this encourages surface erosion.

Pruning.

Little or no pruning is carried out on young palms until harvesting commences, usually at about four years from planting. The palms are then cleared up to permit easy collection of the fruit bunches. The removal of the lower leaves is considered to assist natural pollination. Pruning is undertaken subsequently once a year when all palm trunks are cleaned of ferns and other saprophytic growth. Between the intervals of annual pruning, only those palm fronds that are dead, or impede the harvesting of bunches, are removed by means of a short-handled axe. A larger portion of petiole is allowed to remain than is usually seen in Malaya.

Artificial Pollination.

Artificial pollination is commonly practised but is not general. So far as could be ascertained, the consensus of opinion favours artificial pollination in conjunction with regular manuring with artificial fertilizers. The collection of pollen is carefully supervised, since the fresh conditions of pollen, when applied to the female inflorescence, is of paramount importance in securing satisfactory results. Palms are patrolled every four days, requiring approximately one pollinating labourer for every 170 acres of palms in bearing. To enable the pollen to obtain access to the maximum number of female flowers, the labourers

engaged on the work of artificial pollination are provided with an iron L-shaped hook to open the fibrous sheath enveloping the flowers.

Manuring.

The use of fertilizers is generally undertaken, often before the palms reach the bearing stage. The most usual form of manuring is by the use of Cheribon rock phosphate applied annually at the rate of 2 kilos (4.4 lbs.) per palm. This is equivalent to an application of 242 lbs. of Rock phosphate per acre per annum. The cost of manures amounts to approximately Guilders 3.50 per acre with an additional 45 Guilder cents for application. The Rock phosphate is often broadcast on the surface of the cover crops and is washed into the soil by rain. It is obvious that this method of applying Rock phosphate, if as satisfactory as stated, is very economical.

A large number of manurial experiments are carried out on oil palm estates in collaboration with the staff of the General Experimental Station of the A.V.R.O.S., Medan. The size of the individual plots is usually 30 or 36 palms in 6 or 8 replications.

The form of manurial experiment commonly employed is as follows:—

Phosphoric acid,	Rock phosphate or Gafsa, 2 kg. (4.4 lbs.) per palm every year or two years.
Phosphoric acid and Potash.	Rock phosphate and sulphate of potash, 1 kg. (2.2 lbs.) of each fertilizer per palm every year or two years.
Complete Fertilizer.	Rock phosphate 2 parts, ammonium sulphate 2 parts and sulphate of potash 1 part, 2 kg. (4.4 lbs.) of the mixture per palm every year or two years.
Control.	No manure.

In general, the use of rock phosphate has given the most economical increases. A number of experiments have shown an immediate increase of crop of 60 per cent. as a result of the application of phosphate in this form. In new areas, small manurial trials with maize, *Zea Mays,* are laid down to serve as an indication of any marked deficiency of phosphoric acid. Both oil palms and maize react to phosphate under average conditions in Sumatra. Maize, however, reacts to all three fertilizers; whilst oil palms show relatively little response to nitrogen and potash.

It is thus possible by a series of small plots to obtain a preliminary idea of whether response may be expected with the particular soil, from an application of phosphatic fertilizer. The difference in behaviour of the maize plots may be judged by appearance, and when the plants have reached optimum growth, by the weight of green matter and grain. A number of such trials were examined indicating, in the majority of instances, a deficiency in the soil of phosphoric acid.

In addition to the use of artificial fertilizers, all trash and fruit residues from the factory are removed by the estate light railways and returned to the field.

Harvesting and Transport.

Since harvesting is a very important field operation, a considerable amount of organisation is given to this matter. On the estates visited, all fields are connected with the factory by a system of light railways. Each labourer is allotted a definite area, usually about 15 hectares (37 acres). The harvesting tasks are changed periodically to apportion the work fairly. The strongest labourers are employed in harvesting and become very adept in removing the bunches from the palms, without, under normal circumstances, the assistance of ladders. The fruit bunches are cut with a short axe and the crop is carried to the railway in two baskets supported by a "kandar" stick. The harvesting operators are paid by results, in addition to a minimum wage. With palms of moderate height, a good labourer will collect an average of 1,000 kilos (2,205 lbs.) fruit bunches per day. In the case of ten year old palms, averaging 14 to 15 metres (46 to 49 feet) in height, the average daily crop harvested by each labourer is 800 kilos (1,760 lbs.) fruit bunches delivered to the estate railway.

Yields.

It is, of course, impossible to make any general statement regarding yields. On those estates visited, crop returns appeared very satisfactory. It was stated that, to maintain high yields, regular manuring was necessary. On one estate the average production of palm oil in 1932, from an area of 1,700 acres of ten year old palms, was 22½ cwts. per acre. Higher yields are obtained from areas planted from seeds of high-yielding palms. In one instance, a yield of 4,055 lbs. of oil per acre was recorded from a field of 88 acres of seven year old palms.

Factories.

As is generally known, the system of oil extraction in vogue in Sumatra is the press system. Two types of installation were seen, namely the Stork and Krupp, of Dutch and German manufacture, respectively. These installations have already been described in this Journal, vide Vol. XIX, page 533, and Vol. XXI, page 272.

With regard to the recovery of oil and kernels, factory records examined range as follows:—

Oil obtained from bunches—15 to 18 per cent.

Kernels obtained from bunches—3 to 3.8 per cent.

Acknowledgments.

The writer is indebted to Dr. A. d'Angremond, Director of the General Experiment Station of the A.V.R.O.S. and his scientific staff for the courtesy and assistance given. Also to the managers of the various estates visited.

Abstracts.

THE STEADY ADVANCE IN TEA PRICES.

Mr. L. G. Stephens, writing in "The Financial Times," states that while most tea shares at present prices are already discounting the immediate position, the prospects of better results in the future give scope for further recovery. His article, which strikes an optimistic note, is as follows:—

On several occasions during recent months when reviewing the tea position it has been pointed out that the selling price of tea had fallen to a greater extent than was actually justified by the statistical position of the commodity But as has been the case with so many products during recent years, a surplus of even a moderate amount, combined with the possibility of further accumulations, has been sufficient to have a marked effect on prices at the sales.

Some reflex of this contention in regard to tea has been seen in the advance which has taken place in selling prices for all teas at the auctions since the announcement of the unanimous adoption of the restriction scheme by the producers in India, Ceylon and the Dutch East Indies.

The following table shows the averages at last week's sales, together with a comparison of the same date in 1932 and in 1931:—

		3rd Aug., 1933.	11th Aug., 1932.	13th Aug., 1931.
Northern India	...	11.11d.	7.71d.	9.46d.
Southern India	...	10.92d.	6.61d.	7.45d.
Ceylon	...	1s. 1.78d.	8.07d.	1s.0.50d.
Java	...	9.18d.	4.71d.	6.39d.

It will be seen that the averages are not only well above those of 1932, but also they are ahead of those for the corresponding sale in 1931.

Common Varieties.

So far the teas which have benefited most are the common variety, the latest average for these being 9¾d. per pound, which compares with the lowest point touched of 4½d. per pound.

Medium teas are now coming into keen demand, and at the past week's sale some of these teas are up by 1½d. per pound.

It should be pointed out that the advance of recent weeks has been in spite of the fact that the sales have mostly comprised the finish of last season's teas from Northern India.

The first of the new season's teas from Northern India will shortly be coming up for sale, and also the better quality teas from Ceylon. The auctions will, therefore, be watched with considerable interest. Further good sales are anticipated, the demand being stimulated by the knowledge that there will be a decrease in supplies as the effect of the restriction scheme comes fully into force.

The competition at the auctions has been very keen, and the trade is apparently of the opinion that higher prices will be reached and maintained.

It may be recalled that the restriction scheme is to date as from April 1 last, and is to be in force for a period of five years, the estimated decline for the first year being approximately 121 million lb.

One of the strong points of the scheme is the prohibition of fresh planting during he period of restriction.

The scheme was the subject of lengthy discussions and has been so designed as to be as effective as possible, and the export of tea is now subject to licence by the various Governments.

Producers' Burdens.

It would, indeed, seem that "the old order changeth, giving place to new." Whatever the economists of the past may claim for the laws of supply and demand, producers have had to invent new rules which act more quickly, rather than just wait for the survival of the fittest with a drain on all concerned.

With the chief buying of commodities now in the hands of a few strong groups, with the lesser concerns following their lead, the lot of the producers has indeed been a parlous one. In the case of tea they have had to carry the burden of harvesting and financing crops without the certainty of even getting back their outlay. Thus, with a product such as tea, where the centres of production are within a certain geographical area, a combination of producers is the only logical outcome, and this is possibly of benefit to the consumers also, because, had large areas been forced out of production, there would have been a great shortage of tea later on with a corresponding rise in the price.

The restriction scheme aims at so regulating supplies as to give to growers an adequate return for the risk involved in producing a semi-tropical commodity, without unduly raising the price to consumers.

Propaganda Work.

The various tea associations are also fully aware of the importance of extending the market for tea. In the past India has been the only country to levy a cess for this purpose, the funds so raised being used to carry on propaganda. The chief centres of activity have been in India itself, where, in spite of the fact that this country produces the bulk of the tea, little is retained for internal consumption. Good work has also been done in the United States. Naturally, these efforts have been retarded owing to the depression, but the work has been continued.

It is now hoped to bring all the various producers into a scheme so as to carry on the propaganda as a whole. With Ceylon and the Dutch East Indies providing funds for this purpose, work on a much larger scale can be undertaken.

The Indian Tea Association has also been selling a fair quantity of tea to Russia, as it is realised that it is important, as far as possible, to keep the taste

for tea alive in that country. The contracts that have been made have been on long-term credit, all of which have been duly carried out. But, owing to the recent breaking off of trade relation with that country, the contracts had to be suspended. It is hoped to get these fixed up again.

One of the features in regard to tea is that the consumption in the United Kingdom has continued to expand in spite of the depression through which the country has been passing.

British Market.

The following figures of consumption per capita in the United Kingdom during the last ten years are significant :—

	lbs.		lbs.
1923	8.60	1928	9.15
1924	8.82	1929	9.25
1925	8.85	1930	9.80
1926	8.91	1931	10.30
1927	9.02	1932*	11.00

*Estimated.

As to individual companies, with the reduction in crops, costs will show some advance, but these will on the whole be well below the level of recent years. The stopping of manuring and other economies will tend to keep down costs. Even with restricted crops the earning capacity of most companies will be good, owing to the low figure at which the estates are capitalised. The fluctuations in earnings as represented by 1d. per pound on the last crops, are set forth in the manual published by the " Financial Times."

Inasmuch as the companies have suffered by falling prices, owing to the percentage which a few pence per pound represents, so in the recovery they will benefit.

The share market has been very active, with an all-round advance in prices, the keen demand for stock having found the market in short supply, and buyers have had to advance prices in order to secure the shares required.

While most shares at present prices are already discounting the immediate position, the prospects of better results in the future give scope for further recovery—*The Planters Chronicle.*

GERMINATING COCONUTS ON A NEW VOLCANIC ISLAND, KRAKATOA.†

After being quiescent for more than forty-three years, the Krakatoa volcano renewed its activity in December 1927. Heavy eruptions started from a submarine crater situated in the centre of the basin, between the three islands of the Krakatoa group, and the ejected volcanic materials formed a cone which in January 1928 appeared above the surface of the sea, and formed an island which was 175 metres long and 3 metres high. In the following months activity

† The following interesting account was published as a letter under the signature of W. Docters Van Leeuwen, Leersum, Bergweg, 188 in *Nature* October 18, 1933.

was most severe and a cone 200 metres high was built up having a volume of about twenty-five million cubic metres! This island was soon destroyed by the waves and eventually disappeared. This was Anak* Krakatoa I.

Activity started again on March 25, 1928, but it was not until January 1929 that a second new island rose above the waves. At the end of February the island was about 40 metres high and 275 metres long. In the early days of July this island, Anak Krakatoa II, also was washed away.

Anak Krakatoa III was born on June 3, 1930, and it was destroyed by the sea on August 8. The submarine cone, however, was now so firmly constructed that three days later the fourth child of Krakatoa appeared, which was a healthy baby, and grew in a short time into a big island, Anak Krakatoa IV.

In the month of January 1932, one of the officials of the volcanological service, who paid a visit to the new island, brought me some seedlings, picked up by him on the beach, and I had myself an opportunity of visiting the island in the month of May of the same year. It was then 40 metres high and comprised an eccentric hot crater lake and some solfataras on its margin. The wall of this lake was on one side 40 metres high and very steep, and sloped on the other side gently to the beach, which was more than 1 km. long.

On this beach, which consisted of black sand, a great quantity of pumice and logs was washed ashore and many plant seeds had already germinated. I found many seedlings of common drift plants and of plants of the *Barringtonia* association. The following seedlings were found: *Pandanus tectorum, Canavalia rosea, Ipomoea pes-caprœ, Barringtonia speciosa, Terminalia Catappa, Xylocarpus granatum, Pangomia pinnata,* and 41 germinating coconuts.

This last find was of special interest, as in this case there could be no question at all whether the nuts had been planted or not. No native, with the exception of the coolies of the volcanological service, had dared to land on this still active and treacherous crater, nor was there anything for them to find there. Moreover, the coconuts lay on the beach and were mostly unburied, lying between the pumice and the logs in the same disorderly manner as the seedlings of the other plants, as to which no one questions their distribution by the sea. Some coconuts were just beginning to sprout; others had already formed a bunch of leaves and were rooted firmly in the soil. They were here in exceptionally good condition, as the crabs, which often ruin the germinating nuts, were not present on the beach. We thus find on this new island a strong proof of the ability of the coconut, when washed ashore, to establish itself on the beach without human aid.

After a rest of some months, the crater again started into activity in November and the poorly-developed vegetation was covered over by the ejected volcanic material.

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*Anak is the Malay word for child.

Reviews.

Latex and its Industrial Applications, by Frederick Marchionna.

This book, published in 1933 by the Rubber Age Publishing Co. New York, consists of 1037 pages which includes separate indexes of authors, patentees, patents and subjects. It contains a preface by Professor G. Bruni of the Pirelli Rubber Co. Milan and a preface by the author, together with a brief Historical Introduction.

The first seven chapters of the book, dealing respectively with rubber plants; the planting and cultivation of rubber; collection and extraction of latex; preservation of latex and rubber; behaviour and characteristics of latex; coagulation of latex and preparation of raw rubber; consist mainly of brief introductions followed by useful abstracts of patent and technical literature relating to the problems in each individual chapter.

Chapter VIII, which is the largest section of the book, occupying about 500 pages, contains an introduction on the Direct Use of Latex in Industry, followed by various sections containing, as in the previous chapters, abstracts of patent and technical literature dealing with various specific applications of latex.

Chapters IX, X and XI deal respectively with artificial latex; electro deposition of latex and the structure of rubber. In each of these chapters, a similar treatment is adopted *viz.* an introduction followed by lists of abstracts of patent and technical literature.

The subject matter, as stated by Professor Bruni in his preface, comprises 2490 abstracts of which 1887 are patents and 600 of scientific or technical papers.

The book is of considerable value to all scientific workers who are concerned with latex. Its principal value is as a book of reference, since, as has been indicated above, the principal contents consist of abstracts of patent and technical literature.

The chief criticism which the reviewer has to make is that some of the abstracts of the earlier technical literature might well have been omitted, since they are of no real value at this time, except historically.

In Chapter III on the Collecting and Extracting of Latex, quite a number of patents dealing with tapping tools are abstracted. These might have been omitted, since, as is well known, only about three or four types of tapping knives are now in use on rubber plantations. The majority of the patents for tapping tools, like many other patents, only rest in the dusty archives of various patent offices.

Further, an abstracted description of a tapping tool is not of much value without an illustration.

A few abstracts are misplaced *e.g.* in Chapter IV "The Preservation of Latex and Rubber" p. 114 abstract 346 deals with the treatment of latex to obtain specific properties in the prepared rubber.

Page 119 abstract 372 deals with the character and properties of Castilloa latex and refers chiefly to coagulants of this latex.

Page 123 abstract 383 deals with coagulation phenomena and should be included in Chapter VI.

Athough the author has abstracted articles appearing in the Agricultural Bulletin of the Federated Malay States and the Archief voor Rubber Cultuur of Netherlands India, he does not appear to have abstracted much information contained in the special bulletins or pamphlets on rubber published in these countries. This chiefly affects the question of priority of publication in relation to problems which have been investigated in both countries, since most of the information in these publications has been published separately in other journals and has been abstracted by the author from these journals.

In spite of these criticisms, the author is to be congratulated on the immense amount of time and labour which he must have devoted to this excellent compilation, which is of great value as a book of reference to those engaged in scientific work on behalf of either the rubber producer or manufacturer.

B. J. E.

Coir.

Report on the Attributes and Preparation of Coconut Fibre,
by S. G. Barker, Ph. D., D.I.C., F. Inst. P., M.I. Chem. E., F.R.S.E., F.Z.S., F.T.I.
Empire Marketing Board Bulletin No. 71, September, 1933.

This report is of definite local interest, dealing as it does, with the qualities and uses of a by-product of the copra industry, namely Coir, which is extracted from the husk of the coconut.

It is stated that "at present the whole year's production of coir fibre for spinning is about three and a half million tons. Actually only 100,000 tons are used, the remainder being wasted owing to the fact that no commercial use can be found for it. There is, therefore, an abundance of the raw material and the future of the industry would seem to lie in finding new uses for the fibre and carrying out research work to discover if it can be rendered comparatively cheaply into forms more favourable for utilisation in other directions then those at present".

Extensive information is supplied in the report on the coconut palm and its habitat, and on the methods adopted by the raiats in the different tropical countries in the preparation of coir.

It is an axiom amongst workers engaged in scientific investigation of industrial processes and practice that there is always a good scientific basis for established industrial practice, and, although the methods of soaking and retting coconut husk in most tropical countries may be somewhat primitive, there are sound scientific reasons for each part of the process. The report discusses

these methods and their significance at some length, before passing on to the question of chemical and mechanical methods for quick retting of the husks.

Under this heading, five different modern processes are described and it is stated that the H. G. process with ionized oil, which is adaptable to either factory or co-operative village conditions, is now being developed and large-scale plant is already designed and installed in London. It is interesting to note that in this process use can be made of coconut oil, ionized and suitably treated.

In connexion with sorting the fibre into the market grades of "mat fibre" used in ropes, twines and matting, "bristle fibre" for brushes and brooms, and "curled fibre" for mattresses, stuffing upholstery and as a substitute for horse hair, mention is made of a method, put forward by a British firm of machine makers, for separating the classes of fibre mechanically and keeping distinct the separate qualities of the fibre.

A section is also devoted to utilisation of residues from fibre extraction and many useful suggestions for further work on this question are made.

The properties of coconut fibre are fully reviewed in a section which reveals the obvious uses of coir. For ropes it is to be recommended where elasticity or resistance to decay is desired, especially in ropes subject to the action of sea water. On the other hand, as a textile fibre it has been considered to be of little general value because of its coarseness, harshness, brittleness and colour, qualities which, however, are desirable in other directions. It is thought that chemically and mechanically retted coconut fibre opens up a new vista in the outlook for the future of coir. A new use of importance, which has already passed the experimental stage, is the use and preparation of protective lagging materials for underground pipes and cables. The superior durability and resistance to decay of coir, as well as its absorbent properties for pitch etc. indicate its utility as a road surface reinforcing medium and it is stated that experiments in this regard are now being organised.

The final chapters are concerned with manufacturing processes, and bleaching, along with remarks on the properties and uses of coconut shell.

The report is of considerable interest and value and should stimulate research into the possibility of increased utilisation of coir.

A. T.

Reports of the Field Branch for the Year 1932.

Department of Agriculture, S.S. and F.M.S. Special Bulletin, General Series No. 15. 209 pp. 5 plates. Price 50 cents.

In accordance with what has now become established practice, the reports of the various officers of the Field Branch of the Department, for the year 1932 are published in Bulletin form.

The re-organisation of the Department has resulted in very much greater importance becoming attached to the work of the officers of this Branch than formerly was the case. The gradual systematisation of extension work, and the opening up in the majority of circles of Agricultural Stations and Test Plots, has greatly increased the activities and the utility of this section of the Department and most field officers have now under their charge a certain amount of experimental work in addition to instructional and inspectional activities.

In this respect, these services may now be regarded as having been brought into line with accepted standard practices in other parts of the world.

Through the courtesy of the administrations of the Unfederated States, it has been possible to include accounts of the work done by seconded agricultural officers in these territories, which, it may be pointed out, is, in most States, conducted along lines which have become standardised in the Straits Settlements and Federated Malay States, and the efforts in progress closely correlated thereto.

The reports give an idea of the many lines of work in progress and also afford a review of the agricultural conditions in each area.

On the present occasion, certain of the reports are illustrated by photographs indicating some of the undertakings operated by the Branch.

H. A. T.

List of Experiments at Present in Progress at the Government Experimental Plantation, Serdang.

Department of Agriculture, S.S. and F.M.S. Special Bulletin, General Series No. 16. 29 pp. Price 50 cents.

This publication is issued as a supplement to the the Guide to the Government Experimental Plantation, Serdang published in 1931.

It gives details of the large amount of experimental work in progress on a considerable number of crops.

The nature and scope of the experimental work in hand has been greatly expanded during the past two years. Its inception definitely marks the second stage in the history of the Plantation, whereby trials with possible crops to ascertain their suitability for cultivation have now become supplemented, and to an extent replaced, by definite experimental work. These experiments are designed to investigate cultural and manurial requirements and the methods of manipulating the produce of crops which have been found suitable for cultivation and which have to a greater or less extent entered into commercial cultivation.

The increasing number of, and area under, agricultural crops other than rubber in the Peninsula is one of the most interesting features of Malayan Agriculture at the present time, and in facilitating their development the Serdang Station can fairly lay claim to have played a useful and not unimportant part.

The present publication will, it is believed, prove to be a very necessary and useful adjunct in the hands of visitors to the Station.

For its compilation, Mr. J. N. Milsum, Senior Assistant Agriculturist in charge of the Station, with the other members of the Station Staff, are responsible.

H. A. T.

Departmental.

FROM THE DISTRICTS.

The Weather.

The cool wet weather continued during the first half of December practically throughout the Peninsula, heavy rainfall causing flooding in Kelantan and small floods in some localities along the lower portion of the Perak River. The second half of the month was warmer and fairly dry. While precipitation was up to the average for the month in many places, it was below average in Krian District, in Central Perak, on Cameron Highlands and on the east coast of Pahang.

Remarks on Crops.

Rubber.—The average price of rubber showed but little variation from that of November. The highest and lowest prices in dollars and cents per picul recorded during the month for rubber from small holdings were :—Smoked Sheet $12 to $17.95; Unsmoked Sheet $10 to $15.60; Scrap $1.50 to $7. The average Singapore prices are not available, but are known to be but little different from those for November. The Penang prices for Unsmoked Sheet ranged from $13.30 to $14.60 as compared with $12 to $14.20 in November.

The situation in respect of tapping showed but little change from that described for November. Wet weather interfered with tapping during the first half of the month, while in large portions of the States of Negri Sembilan and Pahang the padi harvest was a further factor contributing towards a reduced output of rubber from small holdings. On the other hand, in Johore, every effort was made to obtain the maximum production in order to meet anticipated expenses at the Mohammedan and Chinese New Year holidays.

In Kelantan, efforts made towards the improvement of native rubber are having a small though increasing effect. Another two small--holders have begun to use hand rollers for preparing sheet and there is increased interest in the use of acetic acid instead of alum as a coagulant.

Mouldy Rot disease continued to be in evidence during the wet weather, but there was some further increase in the use of approved disinfectants in certain areas.

Padi.—The price of padi at the Government Rice Mill, Bagan Serai, at $1.62 per picul, was the same as in November, and there was little change in the general range of prices throughout the country, these being 5 to 13 cents per gantang, except in Kedah, where prices fell considerably, more especially for the new crop now being reaped.

In the important padi-growing areas of Kedah, Province Wellesley, Krian and Malacca, crop prospects remain good. Harvest commenced in Kedah and the Province and was in full progress in several parts of Malacca.

In Pahang, the harvest was nearing completion in the greater portion of the riverine area, where the crop has, therefore, escaped damage from floods. The crop reaped is reported as being good on the whole. Harvest had also commenced in other parts of the State, with the exception of portions of Kuala Lipis District.

In certain localities in the inland districts of Selangor, the planting dates for the longer period varieties of padi were, contrary to departmental advice, so arranged that the harvest fell during the wettest period of the year and in the fasting month. The same is true of the planting dates in the Jelebu and Seremban Districts of Negri Sembilan. In all these areas, loss of crop has occurred owing to the wet conditions which often caused lodging. In Rembau District a good crop was being reaped.

In Kelantan, considerable damage was caused to the standing crop by floods. In Upper Perak, Kuala Kangsar and Larut Districts of Perak, planting has been late and prolonged; rats are more prevalent than usual and crop prospects are, in consequence, uncertain.

In Johore, Padi Planting Rules have been introduced by means of which dates can be fixed for the season's operations as in the Federated Malay States. These Rules should ensure better synchronisation of the season's work and, in consequence, more even ripening of the crop, thus reducing the loss caused by pests.

Coconuts and Copra.—There was again a slight decline in the price of copra which ranged from $2.55 to $2.60 in Penang and elsewhere from $1.50 to $3 per picul.

Interest among Malays in the preparation of improved copra is, on the whole, well maintained. New kilns were completed, or in course of erection, at Sungei Batu in Penang Island, Sungei Tontong in the Dindings and Kubang Ulu in Province Wellesley. In Krian, a good sample of copra has been made on the recently completed brick kiln at Tanah Kebun and work has been commenced on a second kiln on Jalan Bahru. In Pahang, the owners of the original mud-walled kiln at Temerloh have almost completed a second brick kiln and a kiln at Kertau has been completed, while a small mud-walled kiln is being built at Kuala Pahang.

In Selangor, owing to the fasting month, there has been an increased demand for nuts in the inland Districts which has been supplied from the coastal Districts.

Fruit.—It is reported that a crop of durians was being obtained around Manong in Kuala Kangsar District, but that rambutans were not yet ripe. In Selangor, there were good crops of durians, mangosteens and rambutans and smaller crops of minor fruits. Tree fruits were also ripe in the States of Negri Sembilan and Pahang. Durian fetched from 7 to 15 cents each in Central Perak and Negri Sembilan and 5 to 10 cents each in Western Pahang. Mangosteens sold for 45 to 50 cents a hundred in Negri Sembilan but only 25 to 30 cents

a hundred in Pahang; while in the former State, the price of rambutans was 50 to 80 cents a hundred.

A recent census of the area planted with fruit, other than pineapples and bananas, in Pahang shows a total area of 4,000 acres, including the fruit trees planted in holdings of mixed crops.

Coffee.—A heavy second crop of coffee was being harvested in Kuala Langat District of Selangor, where the price for beans was 19 to 20 cents per kati. The number of Malays manufacturing coffee in this District is increasing, while those who have been longer in the business were working overtime to cope with the supplies of cherry. In the Temerloh District of Pahang, coffee seed and seedlings have been supplied to Malays and Chinese for planting up new land. Should the present interest in this crop continue there will be a considerable increase in the area planted with coffee in this District during 1934. In one locality in Johore, small holdings have been planted with Liberian coffee which is showing good growth. Further planting in this locality is expected.

Seedlings of "Blue Mountain" coffee, grown from seed imported from Jamaica during the first half of 1933, were being transplanted into the field on one or two properties on Cameron Highlands. A further supply of seed has been ordered by this Department.

Arecanut.—These palms were yielding crops in most localities, but the price was very low, though varying considerably in different parts of the country. In Johore, sundried split nuts sold for 80 cents to $3 per picul, in Selangor for $2 to $5 per picul and dried nuts from other centres at $1.50 to $3 per picul.

It is reported that, in a number of instances, arecanuts have been dried on copra kilns during wet weather in Batu Pahat District of Johore.

Tobacco.—Prices for sundried tobacco leaves have ranged for the most part from $10 to $30 per picul according to quality, but the top price in Malacca was $35 and in Johore $45 per picul, while in Penang Settlement it was only $20 per picul.

There are no reports of any important changes in the planted area. A recent estimate places the total area planted with this crop in Pahang at 147 acres, yielding an average of 3 piculs of leaf per acre. Of this total, 111 acres are in Raub District.

Agricultural Stations.

At the Selama Agricultural Station, in the standard experiment on the manuring of annual crops, a much better growth was shown by gingelly planted on the plots which received 15 tons per acre of a leguminous cover crop, turned in 5 and 1 week respectively before planting, than on the plots receiving 15 tons of non-leguminous material turned in at the same intervals before planting. No marked differences were noticeable between the various sub-plots treated with inorganic fertilisers in this experiment.

Two cockerels and six pullets of each of the three breeds Rhode Island Red, White Leghorn and Light Sussex were received from England at the Tanah Rata Experiment Station, Cameron Highlands on the 18th December and were installed in the six runs recently prepared.

A severe outbreak of fowl typhoid in the neighbourhood resulted in the death of three Light Sussex pullets and one cockerel and one Rhode Island Red pullet at the Sungei Udang Station in Malacca.

At the Padi Experiment Station, Telok Chengai, Kedah, four strains of the long grained, Indian, 4-months, Kalyaman variety yielded over 500 gantangs per acre. An excellent crop of all other varieties was expected.

The State Agricultural Officer, Perak, and the Agricultural Officer, Krian, visited this Station, Gajah Mati Agricultural Station and Langgar Padi Test Plot on December 23rd.

Padi Test Plots.

The highest yields so far recorded from the Kajang Padi Test Plot in Selangor were obtained during the season just concluded; the three best strains being Padi Kelantan with 446, Nachin 27 with 438 and Radin Siak with 382 gantangs per acre. The high yields are attributed to the effect of ploughing.

Yields from the Kuang Padi Test Plot were, however, poor, owing to damage by the padi fly, *Leptocorisa* sp., and by birds while the grain was ripening. Of the 6½ months strains, Nachin 10 was the best with a yield of 242 gantangs per acre; while of the shorter term varieties, Radin Siak gave 210 gantangs per acre.

A party of 75 leading local padi growers, including the local headmen, visited the Briah Test Plot in Krian on December 4th. Another party of 200 local headmen and cultivators, accompanied by the District Officer, visited the Selinsing Test Plot in the same district on December 7th.

A demonstration for local headmen was held at the Pasir Puteh Experiment Station in Kelantan on December 5th and another at the Central Experiment Station, Kota Bahru, on December 20th.

School Gardens.

The final judging of the School Gardens in Penang Settlement was carried out during the month. This showed that the general standard of the gardens is improving.

Judging for the annual competition in the Negri Sembilan was also completed. The winning schools exhibited a very satisfactory standard of work, Senaling, the cup winner, being an excellent example of what can be achieved under school conditions.

In Malacca Settlement, there was a noticeable increase in the number of gardens reaching a very high standard and the selection of the winning garden was much more difficult than it has been in past years, owing to the uniformly

good results achieved by the first six or eight gardens. The best garden in Malacca was that of Melekek School.

Home Gardens Competitions.

Judging in the State of Negri Sembilan took place in Seremban and in Rembau and Tampin Districts. In the former, results were disappointing, but in the latter the competition produced some outstanding attempts to achieve the ideal *kampong* from the point of view of food production. Some attempts were, however, too ambitious and many of the gardens were of an uneconomic size. Those making a genuine attempt at gardening were selling surplus produce and appeared to be convinced of the economic value of the venture.

In Pahang East, there were 221 home gardens of which sixty obtained above average marks. The special prize in Pekan District was won by a boy of 16 years old and that in Kuantan District by a headman of Beserah.

Sawah Competition.

In the Seremban District of the Negri Sembilan, of 37 competing padi holdings, 12 were inspected for final awards. On the whole, the standard of maintenance was high and indicated in a striking manner what can actually be achieved by diligent and good management.

DEPARTMENTAL NOTES.

Tours.

The Chief Field Officer toured in Penang Settlement and the four northern Districts of Perak from December 8th to 13th inclusive. He inspected the Agricultural Stations at Bukit Mertajam, Selama and Kuala Kangsar; Titi Serong Padi Experiment Station; the Padi Station at Bukit Merah in Province Wellesley and Talang in Kuala Kangsar District and all Padi Test Plots in the area visited.

Appointment.

Mr. A. Thompson, Assistant Mycologist, Department of Agriculture, S.S. and F.M.S. has been appointed Mycologist, Department of Agriculture, S.S. and F.M.S. with effect from the 12th October, 1933, inclusive.

Leave.

Mr. D. H. Grist, Agricultural Economist and Editor, returned from leave on December 4th 1933.

Mr. F. C. Cooke, Copra Research Officer, returned from leave on December 8th, 1933.

MALAYAN AGRICULTURAL EXPORTS, NOVEMBER, 1933.

PRODUCT.	NET EXPORT IN TONS.				
	Year 1932	Jan.-Nov. 1932	Jan.-Nov. 1933	Nov. 1932	Nov. 1933
Arecanuts ...	20,280	18,549	20,086	2,428	2,353
Coconuts, fresh† ...	108,123	200,588	94,102	9,981	7,701
Coconut oil ...	11,932	10,647	16,149	1,437	1,436
Copra ...	97,464	90,690	96,966	12,543	10,201
Gambier, all kinds ...	2,925	2,771	2,294	225	267
Palm kernels ...	1,248	1,098	1,813	125	100
Palm oil ...	7,892	7,300	10,466	1,010	1,219
Pineapples, canned ...	66,291	60,510	54,340	3,807	3,069
Rubber § ...	417,137	376,163	414,631	34,031	41,843
Sago,— flour ...	10,267	9,293	6,034	1,815	2,247
„ — pearl ...	3,128	2,953	2,277	237	360
„ — raw ...	4,148*	3,833*	3,917*	503*	435*
Tapioca,— flake ...	9,028	8,346	9,185	500	494
„ — flour ...	392	88	370*	220	188*
„ — pearl ...	19,977	18,567	16,247	2,003	1,679
Tuba root ...	165½	114½	498	9	62

† hundred in number. § production. * net imports.

Statistical.

MARKET PRICES.

December 1933.

Rubber.—The market price of rubber has been steady during the month, opening at 13 14/16 cents per lb. for Spot loose in Singapore and closing at 14 cents per lb. The average price for the month was 13 9/16 cents per lb. in Singapore, 4 3/16 pence in London and 8 11/16 cents Gold in New York as compared with 13⅛ cents, 4 3/32 and 8½ cents Gold respectively in November.

Palm Oil.—The course of the market Liverpool/Continent during December on a basis of 5 per cent. f.f.a., c.i.f. was as follows:—December 2nd £15.5.0 per ton net, December 9th £15.0.0 per ton net, December 18th £15.0.0 per ton net, and December 27th £15.0.0 per ton net.

Prices in the U.S.A. landed weight per pound in bulk c.i.f. New York/Philadelphia were 2.80 cents Gold on the 2nd December, 2.75 cents Gold on the 9th December, 2.75 cents Gold on the 18th December and 2.75 cents Gold on the 27th December.

The price of palm kernels Fair Average Malayan Quality c.i.f. landed weight on the Continent was Shillings 7/6 per cwt. on December 2nd; Shillings 7/6 per cwt. on the 9th December; Shillings 7/6 per cwt. on December 18th and Shillings 7/6 per cwt. on the 27th December.

Copra.—There was a slight fall in price during December. The highest Singapore price for Sundried during the month was $3.15 per picul, and the lowest price $3.00 per picul, the average price per picul being $3.08 as compared with $3.21 during November.

The mixed quality averaged $2.40 per picul as compared with $2.52 per picul in November.

Coffee.—The price at Singapore for Sourabaya Coffee as in the previous month continued steady, prices ranged according to grade, from $16 to $18 per picul. Palembang coffee averaged $12.25 per picul during the month, being quoted at $12 on the 1st and $12.25 on the 29th; the average figure for November was $12.31.

Arecanuts.—Palembangs averaged $1.96 per picul and Bila Whole $2 per picul as compared with $1.98 and $2 per picul during November. The range of Singapore prices for other grades was Split $2.50 to $4 per picul; Red Whole $3 to $4.50 per picul; Sliced $5 to $7.50 per picul and Kelantan $3 to $3.50 per picul.

Rice.—The average wholesale price of Siam No. 2 ordinary rice per picul in Singapore in November was $3.31 as compared with $3.48 in October. No 1 Rangoon rice averaged $3.10 per picul in Singapore in November, the average price for October being $2.88 per picul.

The average retail market prices in cents per gantang of No. 2 Siam rice in November were:—Singapore 24, Penang 27, and Malacca 27, as compared with 24, 20 and 27 respectively in October.

Tea.—During November the average price quoted in London for Malayan Tea was Shillings 1/0.99. Average prices during November for tea consignments from other countries were as follows: Ceylon, Shillings 1/3.76; Java Pence 11.59; Indian Northern, Shillings 1/1.19 and Indian Southern, Shillings 1/1.29.

Gambier.—The price of Block Gambier remained steady during December at $4 per picul, Cube No. 1 averaged $6.50. Corresponding figures for November were $4 and $7.25 respectively.

Fineapples.—Values increased slightly during December, the average Singapore price per case being as follows:—Cubes $3.14, Sliced Flat $3.04, and Sliced Tall $3.10, as compared with $3.02, $2.94 and $3.07 respectively during November.

Tapioca.—The price of Flake Fair averaged $4.45 per picul as compared with $4.06 in November. Pearl Seed averaged $5.42 per picul a slight increase on the November price of $5.17, and Pearl Medium averaged $5.70 per picul, the average price being $5.50 in the previous month.

Sago.—Pearl-Small Fair increased in price during December, averaging $3.90 per picul during the month; the price was $3.65 in November. Flour-Sarawak Fair averaged $1.79 per picul this being a slight fall in value as compared with November average of $1.80½.

Mace.—Prices fluctuated somewhat during December, the average for the month for Siouw being $64.00 per picul, and $42.00 per picul for Amboina.

Nutmegs.—There was a slight increase in the price of 110's during the month as compared with November prices the average being $19.60 per picul, 80's fell slightly in value, averaging $24.40 per picul.

Pepper.—Average Singapore prices during December were as follows:—Singapore Black $13.30 per picul; Singapore White $22.60 and Muntok White $23.60; the corresponding figures for November were $13.00, $22.25 and $22.87 per picul respectively.

Cloves.—There was a slight fall in the price of Zanzibar during the month as compared with November price, the average price was $38.00 per picul during December. Amboina remained steady as in the previous months at $45.00 per picul. These are nominal prices.

The above prices are based on London and Singapore daily quotations for rubber; on the Singapore Chamber of Commerce Weekly Reports for the month and on other local sources of information. Palm oil reports are kindly supplied by Messrs. Guthrie & Co., Ltd., Kuala Lumpur, and the Singapore prices for coffee and arecanuts by the Lianqui Trading Company of Singapore.

1 picul = 133⅓ lbs. The Dollar is fixed at two shillings and four pence.

Note.—The Department of Agriculture will be pleased to assist planters in finding a market for agricultural produce. Similar assistance is also offered by the Malayan Information Agency, 57, Charing Cross, London, S.W.1.

GENERAL RICE SUMMARY.*

For November, 1933.

Malaya.—Gross foreign imports of rice (including stocks available for re-export) during November 1933, amounted to 51,261 tons, as compared with 52,474 tons in November 1932, of which 49 per cent. were consigned to Singapore, 25 per cent. to Penang, 7 per cent. to Malacca, 16 per cent. to the Federated Malay States and 3 per cent. to the Unfederated Malay States.

Of these imports, 55 per cent. were from Siam, 40 per cent. from Burma, 4 per cent. from Indo-China and 1 per cent. from other countries.

Total foreign exports of rice from Malaya in November 1933, were 13,875 tons (including 171 tons local production) as compared with 17,553 tons in November 1932.

Of these exports 72 per cent. were consigned to Netherlands India and 28 per cent. to other countries.

Net imports for the period January to November 1933, were 395,367 tons as compared with 370,105 tons during the same period for 1932, an increase of 6.7 per cent.

India and Burma.—Total foreign exports of rice during October 1933, were 91,000 tons as compared with 99,000 tons in the previous month and 72,000 tons in October 1932, a decrease of 8 per cent. in respect of the previous month and an increase of 26 per cent. in respect of the same period in the previous year.

Total exports during the period January to October 1933, were 1,655,000 tons as compared with 1,866,000 tons for the corresponding period of 1932, a decrease of 11 per cent.

Siam.—Exports (approximate) during November 1933, amounted to 113,685 tons as compared with 135,908 tons in November 1932, an increase of 20 per cent.

Netherlands India, Java and Madura.—At the end of October 1933, the area harvested amounted to 8,820,000 acres, an increase of 131,000 acres or 1 per cent. as compared with the corresponding date of 1932 : the area damaged was 441,000 acres an increase of 86,000 acres or 24 per cent. as compared with 1932, and additional plantings awaiting harvesting amounted to 1,255,000 acres an increase of 235,000 acres or 23 per cent. The total acreage at the end of October 1933, amounted to 10,516,000 acres, an increase of 452,000 acres or 4 per cent. as compared with the same period in 1932.

Imports of rice into Java and Madura during January to September 1933, totalled 104,344 tons, a decrease of 9,456 tons or 8 per cent. as compared with the same period of 1932.

Imports of rice into the Outer Provinces during January to September 1932, amounted to 192,702 tons.

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* Abridged from the Rice Summary for November 1933, compiled by the Department of Statistics, S.S. and F.M.S.

French Indo-China.—Entries of padi at the port of Cholon from January to November 1933, amounted to 1,034,000 (metric) tons, a decrease of 14,000 tons or 1 per cent. as compared with the same period of 1932.

Exports of rice from Saigon for the period January to November 1933, totalled 1,162,000 tons, an increase of 72,000 tons or 7 per cent. as compared with the corresponding period of 1932.

Ceylon.—Imports for the period January to October 1933, totalled 358,626 tons, a decrease of 13,193 tons on the imports for the same period of 1932.

Of these imports 19 per cent. were from British India, 81 per cent. from other countries.

Europe and America.—Quantities of rice shipped from the East were :—

(*a*) To Europe for the period January 1st to November 16th, 1,180,759 tons, an increase of 252,370 tons or 27 per cent. as compared with the same period of 1932. Of these shipments 47 per cent. were from Burma, 2 per cent. from Japan, 43 per cent. from Saigon, 7 per cent. from Siam and 1 per cent. from Bengal, as compared with 53 per cent. from Burma, 3 per cent. from Japan, 36 per cent. from Saigon, 5 per cent. from Siam and 3 per cent. from Bengal in 1932.

(*b*) To the Levant, period January 1st to October 21st 1933, 22,989 tons, a fall of 24,156 tons or 51 per cent. as compared with the same period of 1932.

(*c*) To America and the West Indies for the period January 1st to October 13th 1933, 141,352 tons, an increase of 28,567 tons or 25 per cent. as compared with the same period of 1932.

MALAYA RUBBER STATISTICS

ACREAGES OF TAPPABLE RUBBER NOT TAPPED ON ESTATES OF 100 ACRES AND OVER, FOR THE MONTH ENDING NOVEMBER, 1933.

STATE OR TERRITORY	Acreage of Tappable Rubber end 1932	ESTATES WHICH HAVE ENTIRELY CEASED TAPPING		ESTATES WHICH HAVE PARTLY CEASED TAPPING		Total (3) + (5)	Percentage of (7) to (2)
		Acreage	Percentage of (3) to (2)	Acreage	Percentage of (5) to (2)		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
STRAITS SETTLEMENTS :—							
Province Wellesley	44,734	1,397	3.1	7,479	16.7	8,876	19.8
Dindings	6,969	209	3.0	762	10.9	971	13.9
Malacca	111,780	4,822	4.3	16,978	15.2	21,800	19.5
Penang Island	1,635	626	38.4	205	12.5	831	50.8
Singapore Island	28,269	9,730	34.4	5,139	18.2	14,869	52.6
Total S.S. ...	193,387	16,784	8.7	30,563	15.8	47,347	24.5
FEDERATED MALAY STATES :—							
Perak	250,951	5,200	2.1	35,428	14.1	40,628	16.2
Selangor	308,379	7,595	2.5	41,092	13.3	48,687	15.8
Negri Sembilan	228,541	7,342	3.2	20,824	9.1	28,166	12.3
Pahang	38,141	6,139	16.1	5,596	14.6	11,735	30.7
Total F.M.S. ...	826,012	26,276	3.2	102,940	12.4	129,216	15.6
UNFEDERATED MALAY STATES :—							
Johore	325,747	23,597	7.2	34,413	10.6	58,010	17.8
Kedah (*a*)	114,551	3,784	3.3	7,370	6.4	11,154	9.7
Kelantan	21,175	7,840	37.0	2,303	10.9	10,143	47.9
Trengganu (*b*)	4,352	Nil	Nil	2,072	47.6	2,072	47.6
Perlis (*a*)	957	177	18.5	468	48.9	645	67.4
Total U.M.S. ...	466,782	35,398	7.6	46,626	10.0	82,024	17.6
TOTAL MALAYA ...	1,486,181	78,458	5.3	180,129	12.1	258,587	17.4

Notes :— (*a*) Registered companies only and are rendered quarterly.

(*b*) Registered companies only.

The above table together with a Summary, was prepared and published by the Statistics Department, S.S. and F.M.S. in December, 1933.

MALAYA RUBBER STATISTICS — TABLE I

STOCKS, PRODUCTION, IMPORTS AND EXPORTS OF RUBBER, INCLUDING LATEX, CONCENTRATED LATEX AND REVERTEX, FOR THE MONTH OF NOVEMBER 1933 IN DRY TONS.

Territory	Stocks at beginning of month 1			Production by Estates of 100 acres and over		Production by Estates of less than 100 acres estimated 2		Imports				Exports including re-exports				Stocks at end of month		
								during the month		January to Oct 1933		during the month		January to Nov. 1933				
	Ports	Dealers	Estates of 100 acres and over	during the month	January to Nov. 1933	during the month	January to Nov. 1933	Foreign	From Malay States & Labuan	Foreign	From Malay States & Labuan	Foreign	Local	Foreign	Local	Ports	Dealers	Estates of 100 acres and over
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
MALAY STATES :—																		
Federated Malay States ...	...	13,616	12,017	12,174	124,437	10,092	99,818	Nil	Nil	Nil	Nil	16,542	6,404	161,825	65,291	...	12,983	11,958
Johore ...	...	3,000	3,056	3,926	39,913	4,944	48,317	Nil	2	Nil	121	1,530	6,958	15,470	72,443	...	3,196	3,244
Kedah ...	...	437	2,121	2,733	26,388	1,652	15,212	Nil	Nil	Nil	Nil	1,351	2,852	13,832	28,296	...	506	2,234
Perlis ...	...	16	10	8	92	33	168	Nil	Nil	Nil	Nil	Nil	32	Nil	270	...	21	14
Kelantan ...	...	426	207	200	2,029	452	5,823	126	Nil	1,049	Nil	101	813	908	7,777	...	309	188
Trengganu ...	...	55	50	180	1,548	90	773	Nil	Nil	Nil	Nil	Nil	270	Nil	2,321	..	55	50
Total Malay States	...	17,550	17,461	19,221	194,407	17,263	170,111	126	2	1,049	121	19,524	17,329	192,035	176,398	...	17,070	17,688
STRAITS SETTLEMENTS :-																		
Malacca ...	...	3,197	1,289	1,490	14,777	3,036	26,778	1	17,414	15	177,063	3,829	Nil	44,955	Nil	...	2,943	1,285
Province Wellesley	...	1,049	689	551	5,737			Nil		Nil						...	1,307	588
Dindings ...	...	43	177	109	1,101			Nil		Nil		7,217		72,064		...	53	202
Penang ...	1,750	5,527	11	10	59			1,542		9,423						3,995	5,764	9
Singapore ...	4,741	30,440	125	164	1,661			13,179		103,457		24,029		206,779		2,542	31,662	123
Total Straits Settlements	6,491	40,256	2,291	2,324	23,335	3,036	26,778	14,722	17,414	112,895	177,063	35,075	Nil	323,798	Nil	6,537	41,729	2,207
TOTAL MALAYA	6,491	57,806	19,752	21,545	217,742	20,299	196,889	14,848	17,416	113,944	177,184	54,599	17,329	515,833	176,398	6,537	58,799	19,895

TABLE II
DEALERS' STOCKS, IN DRY TONS 3

Class of Rubber	Federated Malay States	S'pore	Penang	Province We'sly D'dings M'cca.	Johore	Kedah
20	21	22	23	24	25	26
DRY RUBBER	9,499	26,778	4,830	4,130	1,285	177
WET RUBBER	3,484	4,884	934	173	1,911	329
TOTAL ...	12,983	31,662	5,764	4,303	3,196	506

TABLE III
FOREIGN EXPORTS

PORTS	For month	January to Oct. inc. 1933
Singapore ...	33,458	318,141
Penang ...	12,202	116,770
Port Swettenham.	7,968	69,901
Malacca ...	971	11,021
MALAYA ...	54,599	515,833

TABLE IV
DOMESTIC EXPORTS 4

AREA	For month	during the year 1933
Malay States ... / Straits Settlements	40,486	405,419
MALAYA ...	40,486	405,419

Notes :—1. Stocks on estates of less than 100 acres and stocks in transit on rail, road or local steamer are not ascertained.

2. The production of estates of less than 100 acres is estimated from the formula : Production + Imports + Stocks at beginning of month = Exports + Stocks at end of month, + Consumption, *i.e.*, Column [7] = Columns [13] + [14] + [17] + [18] + [19] + 12 tons local consumption during the month —[2]—[3]—[4]—[5]—[9]—[10]. For the Straits Settlements, Columns [9] and [10] represent purchases by dealers from local estates of less than 100 acres, reduced by 15 % to terms of dry rubber.

3. Dealers' stocks in the Federated Malay States are reduced to dry weights by the following fixed ratios: unsmoked sheet, 15; wet sheet, 25 scrap, lump, etc., 40; stocks else where are in dry weights as reported by the dealers themselves.

4. Domestic exports are estimated by deducting the average monthly dry weight of foreign imports over a period of 2 months from the gross foreign exports of the later month, the foreign exports of the Malay States being domestic production.

5 The above, with certain omissions, is the Report published by the Registrar-General of Statistics, S.S. and F.M.S., at Singapore on 22nd December .1933.

METEOROLOGICAL SUMMARY, MALAYA, NOVEMBER, 1933.

Locality	Air Temperature in degrees Fahrenheit							Earth Temperature		Rainfall								Bright Sunshine		
	Means of			Absolute Extremes						Total		Most in a day	Number of days					Total	Daily Mean	Per cent
	A. Max.	B. Min.	Mean of A and B	Highest Max.	Lowest Min.	Lowest Max.	Highest Min.	At 1 foot	At 4 feet			Amt.	Precipitation .01 in or more	Precipitation, .04 in or more	Thunder-storm	Fog morning obs.	Gale force 8 or more			
	°F	°F	°F	°F	°F	°F	°F	°F	°F	in.	mm.	in.								
Railway Hill, Kuala Lumpur, Selangor ...	89.4	72.0	80.7	92	70	84	74	83.2	84.3	6.44	163.6	1.24	21	16	7	9		129.30	4.31	36
Bukit Jeram, Selangor ...	87.0	72.1	79.5	90	70	83	75	82.9	85.2	8.41	213.6	1.54	21	19	3			136.75	4.56	38
Sitiawan, Perak ...	87.8	72.6	80.2	93	70	79	75	83.3	84.9	7.99	203.0	1.52	16	11	4			146.70	4.89	41
Temerloh, Pahang ...	86.0	72.5	79.2	90	71	78	74	82.8	85.2	5.85	148.6	0.77	24	22		1	1	125.55	4.19	35
Kuala Lipis, Pahang ...	85.4	71.4	78.4	90	70	75	73	82.0	83.9	14.42	366.3	2.71	27	24	2	24		112.80	3.76	31
Kuala Pahang, Pahang ...	83.5	73.5	78.5	88	71	77	76	81.7	83.7	21.54	547.1	4.32	24	22	1			140.70	4.69	39
Mount Faber, Singapore ...	85.2	72.4	78.8	89	70	79	74	80.1	81.6	9.12	231.7	3.89	23	17	5			99.15	3.31	27
Butterworth, Province Wellesley ...	85.0	73.2	79.1	89	70	77	76	82.2	84.2	9.72	246.9	1.78	19	16	1		1	145.15	4.84	41
Bukit China, Malacca ...	84.3	73.3	78.8	90	71	80	75	81.6	83.2	4.13	104.9	0.79	19	12				130.40	4.35	36
Kluang, Johore ...	85.8	71.5	78.7	90	70	79	73	80.5	81.6	15.42	391.7	4.36	23	16	1	6		105.10	3.50	29
Bukit Lalang, Mersing, Johore	83.3	71.9	77.6	89	70	76	73	80.0	81.0	24.58	624.3	5.39	29	25	1	1	1	112.35	3.75	31
Alor Star, Kedah ...	85.7	72.7	79.2	90	70	76	75	83.1	84.8	7.75	196.9	2.68	17	14	6	1		138.55	4.62	39
Kota Bahru, Kelantan ...	82.8	72.7	77.7	91	71	74	75	80.8	83.4	39.57	1005.1	7.24	24	22				120.55	4.02	34
Kuala Trengganu, Trengganu	83.2	72.3	77.7	89	70	76	74	80.1	82.0	26.50	673.1	3.46	24	20			1	118.90	3.96	33
HILL STATIONS.																				
Fraser's Hill, Pahang 4268 ft. Pahang ...	71.2	61.8	66.5	78	59	63	64	70.9	71.5	13.45	341.6	1.76	26	24	1	23		85.50	2.85	24
Cameron Highlands, Tanah Rata, Pahang 4750 ft. ...	70.7	57.6	64.1	73	52	64	61	69.3	69.6	12.12	307.9	2.15	25	23		1	3	86.30	2.88	24
Cameron Highlands, Rhododendron Hill, Pahang 5120 ft. ...	70.5	58.9	64.7	74	57	62	61			12.14	308.4	2.18	25	23		2	3	91.30	3.04	25

Compiled from Returns supplied by the Meteorological Branch, Malaya